CIVIL ENGINEERING

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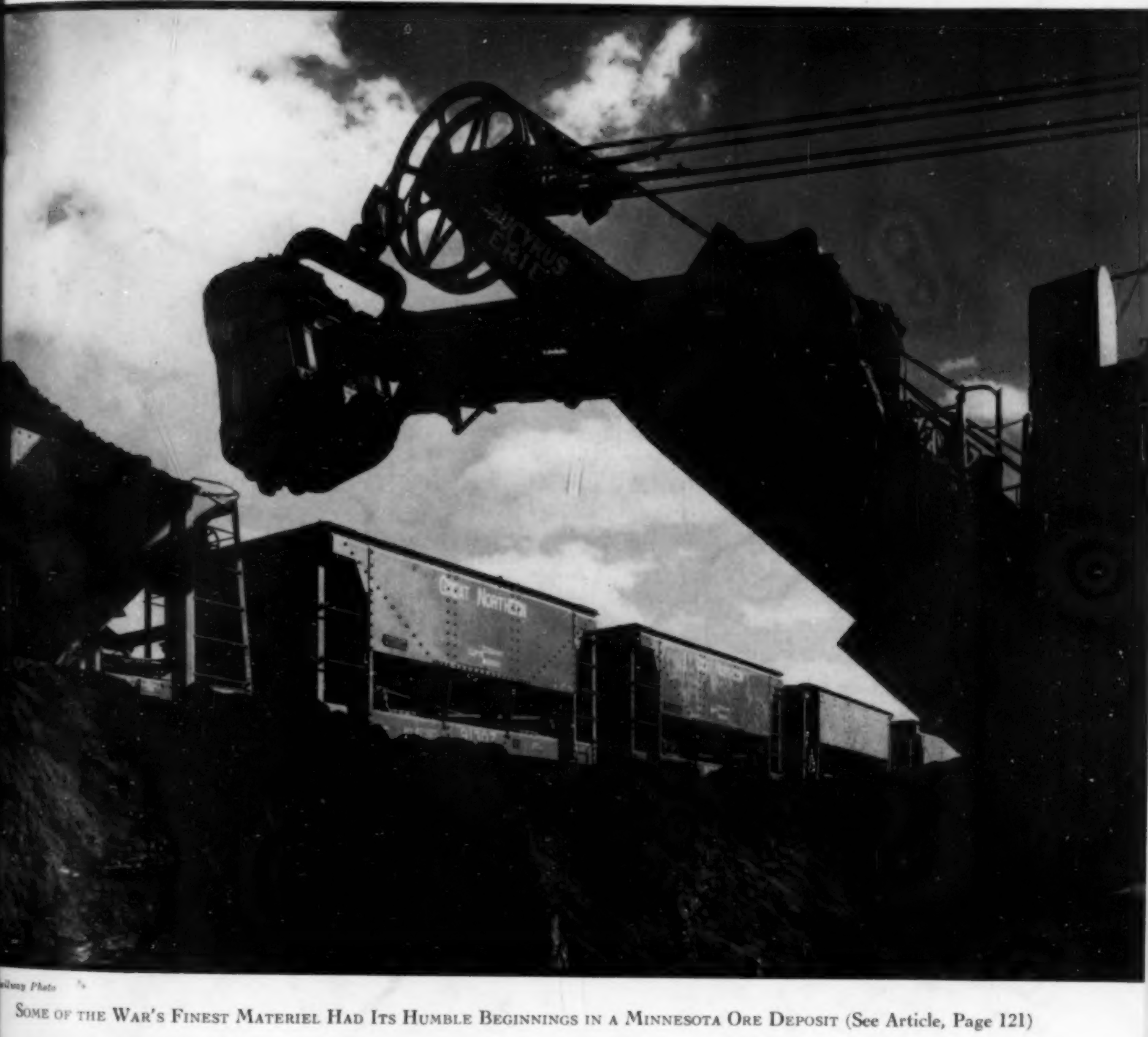

Railway Photo

Some of the War's Finest Materiel Had Its Humble Beginnings in a Minnesota Ore Deposit (See Article, Page 121)

Volume 15 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — Number 3

MARCH 1945

Among Our Writers

orge Havas, after completing engineering education in Stuttgart, Germany, started his professional career in Cuba. After 4 years as resident engineer for a sugar company, he joined the forces of Henry J. Kaiser in 1928, while building the Cuban Highway, and has been with him since. He is Chief Engineer of Henry J. Kaiser Co.; Kaiser Co., Inc.; and Kaiser Industries.

Donald Kennedy (U. of Mich., '21) resigned as Michigan State Highway Commissioner in 1942 to join the automotive and allied industries' Automotive Safety Foundation. He is vice-chairman, National Interregional Highway Committee, and was 1942 president, Am. Assoc. of State Highway Officials. He is the author of recent highway reports for U.S. Senate postwar planning committee and U.S. Chamber of Commerce conference committee on urban problems.

B. Irwin (Ohio Northern U.) has been with the Grand Northern Ry. 36 years—13 years in the engineering dept., ending as office engineer; 7 years as chief clerk to the general manager; 7 years on operating analyses and coordination projects; and since 1936, as assistant to the vice-president.

E. Robinson served in the last war with the 1st Engineers in France. Between wars he served on rehabilitation of the Florida East Coast Ry., as construction engineer on highways and bridges in Texas, and as consulting engineer on municipal and airport construction at Tampa, Fla. Since 1941 he has been serving with the U.S. Army Air Forces as Colonel, C.E.

oward L. Cook (Coe College and State U. of Iowa, B.S. in C.E. '29) spent 5 years with a consultant in hydraulics and hydrology, and 6 years on research with the Soil Conservation Service. In 1940 he became Technical Adviser on Hydrology for the flood-control survey program of the U.S. Dept. of Agriculture. He is now in the Office of Water Utilization of the War Food Administration.

A. Anderson (Kans. State Col., B.S. in C.E. '14, C.E. '20) served the A. T. & S. F. Ry. before World War I, when he earned an ensign's commission in the Navy. Later he reached the position of Division Engineer with the Kansas Highway Commission. Since 1923 he has been with the Portland Cement Assoc., for the past 9 years as Manager of the Highways and Municipal Bureau.

ayle McFadden (Ala. Poly. Inst. '14), after 12 years in the consulting practice of engineering, joined the U.S. Engineer Dept. in 1932. He was in charge of the construction of La Guardia Airport in New York, Chief of Operations for all work by the U.S. Engineers at the Washington, D.C., National Airport, and is now Civil Engineering Consultant and Chief of Runways, Roads and Railroads Section, Military Construction Branch, Engineering and Development Div., Office, Chief of Engineers.

euben M. Haines (Mass. Inst. of Tech. S.M. in C.E. '35) has been employed by the U.S. Engineer Dept. since 1935. He has been soils engineer on numerous flood-control and power projects throughout New York and New England. Since the summer of 1942, he has been soils engineer on military construction projects in the Office, Chief of Engineers.

R. Charles (Walsall Tech. Col. '25; Natl Diploma in Mech. Eng., London U. '30) was in charge of important work in the chemical field for three British firms before becoming chief engineer of Magnesium Elektron Ltd. in 1936. On request of the U.S. Government, he was loaned to Basic Magnesium, Inc., 1941–1943.

Prescott Folwell, James B. French, Andrew J. Provost, Jr., and T. Kennard Thomson are Society members of long standing. The interesting account of their trip to Europe in 1889 under Society auspices began in the January issue, in which appeared also brief biographical accounts of all four co-authors.

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Volume 15 — March 1945 — Number 3

Decentralization—Key to Growth of Kaiser Organization

By George Havas, Assoc. M. Am. Soc. C.E.

Chief Engineer, Kaiser Company, Inc., Oakland, Calif.

Henry Kaiser has been called a "miracle man" of construction. Investigation shows, however, behind the apparent miracles a lot of hard work and a very efficient organization. The story of the growth of the Kaiser Company from Boulder Dam days to the present has been told many times. Looking beyond the mere evidences of growth, the underlying reasons are not so apparent. In this article, Mr. Havas evaluates the relationship between the management of the company and its operating officers which has developed the talents of all top personnel. This paper was presented before the Los Angeles Section of the Society.

"How can the Kaiser organization carry on so many activities?" The answer could be made very simple, namely, by hard work. As you probably guess, however, there is a lot behind these two simple words.

At a launching in Richmond, an official of the Maritime Commission asked me point blank who I was and what I did. I told him that I was connected with the engineering activities of the Kaiser organization and that my office was in the Latham Square Building in Oakland. "Oh, I see" he answered, "then you are working on Kaiser's postwar plans. I understand that is the function of the Oakland main office." The gentleman has been stationed in Oakland almost three years, and although most of his activities are connected with Kaiser-owned or Kaiser-managed shipyards, he did not know what happened elsewhere in the organization.

This incident gives one answer to the question raised and that is "decentralization." As soon as an enterprise is established, it is made self-sufficient, and the home organization is not burdened by the routine details.

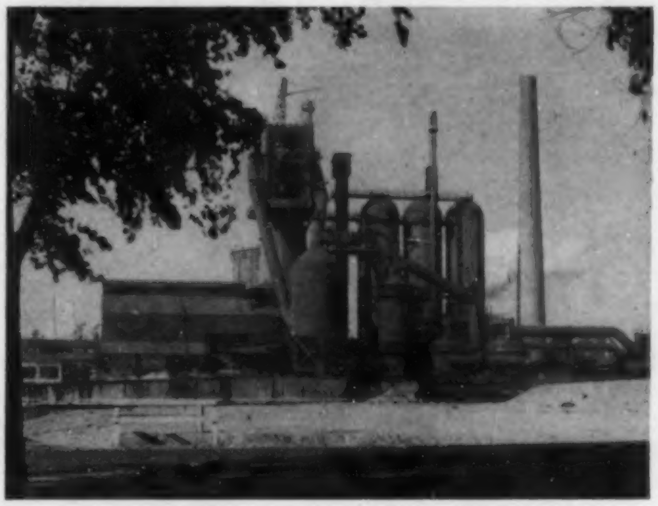
There are several engineering organizations within the Kaiser organization. There are no fast and set rules which cannot be changed if conditions indicate that a change is desirable. The lack of inflexible procedures eliminates red tape (rather reduces red tape) which in turn obviously results in more accomplishment. As an example, the first shipyards were conceived and designed in the Oakland main office, particularly Shipyard No. 1 in Richmond, Calif., and in the Portland Yard of the Oregon Shipbuilding Company.

As soon as construction began under decentralized management, new organizations were established at the site of the work. What was the result? The additions to the original yards were designed and built by men who were best qualified to do so by virtue of the fact that they could observe the actual production and thereby devise improvements in laying out the new facilities. The records obtained in these shipbuilding centers, which can be expressed in increased production and reduced costs, indicate the wisdom of the procedure. Had the central organization continued with further detail work, it would have followed by natural process more or less the originally established lines. Another advantage was that this central organization was made available for other detail work.

Construction of the Fontana steel plant was approved in February 1942. Engineering work started in March. Ground was broken in April, and the first blast furnace on the Pacific Coast was blown in the last day of the same year. This accomplishment of speed is something to be proud of and something which could not have been reached without the cooperation of many prominent engineers.

Few people realize, however, that many years of hard work preceded the date of February 1942. Statistical information and economic studies were collected galore; plant sites were investigated, coal and ore sources developed.

It is truly unfortunate that some people brand this steel plant a "war plant." It actually was conceived long before the war broke out in Europe. Quick de-



First Blast Furnace on the West Coast—Fontana
"Blown in" Last Day of 1942

KAISER'S SHIPYARD PERSONNEL GRADUATED FROM JOBS LIKE THIS
Grand Coulee Dam Conveyor System, Looking West

GENERAL VIEW OF PERMANENTE CEMENT PLANT
Kilns—Note Man Standing, in Center

SHASTA CONVEYOR BELT, OF TIMBER CONSTRUCTION
Was $9^1/_2$ Miles Long, and Handled 1,100 Tons of Sand and Gravel per Hour, in Five Different Sizes

cisions had to be made in connection with the changes required by the emergency, but the ground work was laid and the decisions were based on sound judgment and not on guesswork.

The same thing applies to the birth of the Permanente cement plant. A contract was signed on June 6, 1939, with the U.S. Bureau of Reclamation to furnish 6,000,000 bbl of cement for Shasta Dam, and a sack of Permanente cement was presented to Mr. Kaiser as a Christmas present the same year. Studies which lasted more than four years culminated in the construction of this plant, which is today the largest single cement plant in the world.

Basically, the Kaiser organization is a construction organization. This provides another reason why so many seemingly unrelated activities can be carried on successfully and completed quickly. Normally it takes years of study to design a dam. After the design has been completed, drawings are made, specifications drawn up, and bids called for. Depending upon the size of the project, from 30 to 60 days are usually allowed for the contractors to prepare their bid.

The designer of the dam seldom worries about construction details. Still, approximately 25% of the total cost of a dam is represented by temporary structures and facilities which must be provided if it is to be built. The contractor's engineers have to decide in the short time allotted how to build the dam, design the facilities required, estimate the cost of these facilities, estimate the cost of the construction, and they had better be right. This calls for ingenuity, courage, and adaptability.

An analysis usually reduces the most intricate-looking problem to a very simple fundamental. Most people, however, are too busy in this age of specialization to analyze matters which are foreign to their own specialty, and take the easy way out—call upon a specialist.

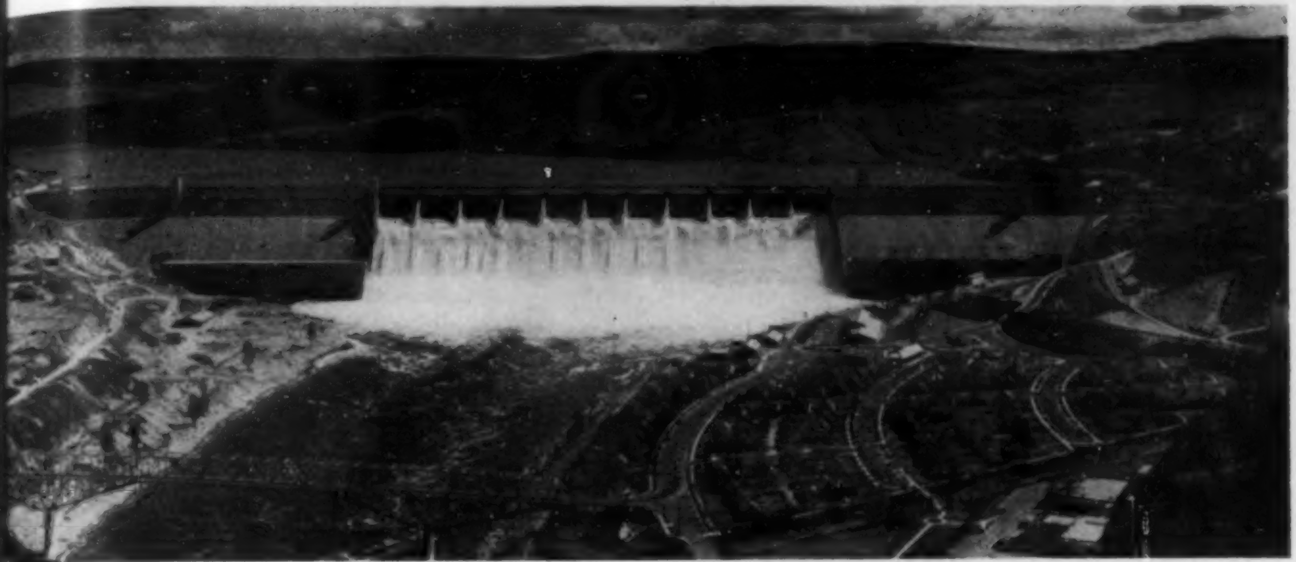
USE COMMON SENSE

A slogan which hung on the wall of a resident engineer of the U.S. Engineers Corps said: "If everything else fails, use common sense." There are many hidden talents in a large organization and if common sense is applied to the problems, these hidden talents are usually discovered.

In Fontana the Kaiser Company was called upon to design an ingot mold foundry. Engineers of the Company knew little about ingot mold foundries, so a nationally known engineering organization which specialized in foundry design was called upon. As the plans were developed it was found necessary to provide a sand-handling system. This was very important in the manufacture of castings. The consultant suggested that a contract be awarded to a manufacturer giving him a blank order so that he might design the equipment and then furnish a price on it. The consulting firm refused to design this unit, stating that they were not qualified.

Not liking to give anybody a blank check, the Company's engineers investigated the difficult problem and discovered that the sand-handling system consisted of a bucket elevator, a few screens, a few belt conveyors, bins and gates, all of which could be designed by any one of a dozen engineers in the Company. The mystery gone, the design was completed with Company forces and the foundry is now producing 2,500 tons of castings per month.

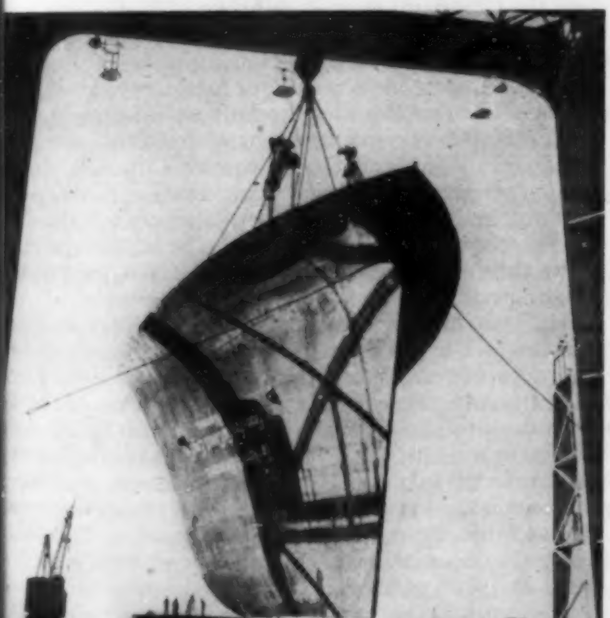
During the early stages of the preliminary design of the blast furnace, a consulting engineering firm in the East was engaged. The problem was placed before them: to build a furnace of 1,200-ton capacity. They were very much interested and estimated that the time



GRAND COULEE DAM ON THE COLUMBIA RIVER

required for the design would be about five months. Inasmuch as there were only eight months in which to design and build the furnace and the necessary accessories, it was impossible to allow so many months for preliminary studies. Blast furnace operation involves a major material-handling problem, the consultant said. A 1,200-ton furnace requires the handling of almost 3,500 tons of materials per day. And there are four different kinds of raw materials!

In those days the Kaiser Company was transporting from Redding to Shasta Dam over a $9^1/_2$-mile-long conveyor belt, 1,100 tons of sand and gravel per hour and in five different sizes. So you see it was not necessary



KAISER TACKLED SHIPBUILDING AS A CONSTRUCTION ENGINEER WOULD TACKLE IT; DELIVERING A LOAD AT A RICHMOND YARD

to call on another specialist for material handling. Incidentally, the preliminary design of the blast furnace required less than four weeks, and all raw materials are handled by a conveyor-belt system.

The Redding-Shasta Dam conveyor belt came into being as a result of a challenge: "It could not be done." It is dangerous to make such a statement before Mr. Kaiser. The logical means of transportation was the existing Southern Pacific railroad line. Difficulties were foreseen due to interference from the main-line traffic on a single-track stretch of the railroad, and economies had to be considered. Construction of a separate railroad was impractical. A conveyor line was suggested.

During the ensuing investigation, it was discovered that the $9^1/_2$-mile conveyor could not be built—simply because such a long line had never been built before. There were many obstacles, raised mainly because of the different sizes of materials to be handled, each of which had a different trajectory at transfer points, and there were 24 transfer points. The belts could not be cleaned. It would not be possible to change the sizes of materials often enough. And so on.

The conveyor line was designed and built, and 11,000,000 tons of sand and gravel delivered without interruption. Moreover, had railroad transportation been relied upon, the construction of Shasta Dam would undoubtedly have been delayed during the war, when the Southern Pacific had to handle as many as 63 trains a day on that single-track line.

COOPERATION ESSENTIAL

Construction of Bonneville Dam on the Columbia River was another job which "could not be done." Particularly was this the comment when Mr. Kaiser announced that the dam would be built by his "boys." The average age of the "boys" in those days was very close to 30. The bonding companies refused to furnish the required performance bonds. Mr. Kaiser arranged for personal surety bonds.

The Columbia River was very treacherous. Where was there another successful example of dewatering a cofferdam in a river carrying 1,000,000 cu ft per sec of peak flood to a depth of 60 ft? The only similar work was done in Russia on the Dnieper River Dam, where the cofferdam was only 40 ft deep. With the full cooperation of the U.S. Corps of Engineers, who were in charge of

PERMANENTE, LARGEST SINGLE CEMENT PLANT IN THE WORLD

the project, hydraulic model studies were conducted to determine the behavior of the cofferdam cribs, loads on holding lines, etc. There was no textbook information available.

The north river bank was widened first to provide sufficient waterway to pass the mighty Columbia by the south cofferdam during the first step of construction. The original plans called for excavation with a floating dredge. This did not turn out fast enough to meet the construction schedule and was very costly. Use of a walking dragline on the shore was recommended. The manufacturer of the equipment refused to accept the responsibility. The dragline was not the proper equipment; it would not work. Mr. Kaiser said that he would be glad to take the name plate off. Work went ahead and the channel was widened on time with the dragline. The cofferdams were built as predicted. Stresses on the holding lines were within 10% of the model tests. The dam was built and the "boys" got a little older. This might be off the subject, but it illustrates the spirit of the organization which makes it possible for it to do the apparently impossible and thereby grow and expand.

CIVIL ENGINEERS IN MANAGEMENT

Management of the Kaiser organization is composed largely of civil engineers. The management is assisted, generally by three staff organizations: administrative, legal (which includes industrial relations), and engineering.

In the development of the engineering department, the usual steps from a non-productive to a productive status were passed through. At first the engineering department was considered a necessary evil. Men always graduated from engineering into supervisory or other managerial positions, and not many people know, even within the organization, that the most prominent members of the management are civil engineers. Today the engineers are coming into their own.

In the Oakland main office the engineering department has several distinct functions: design, procurement (expediting), estimating, programming, production control, and development.

The design section is divided into the usual departments: structural, mechanical, electrical, civil. These are supplemented by staff consultants on process design. Inasmuch as it is many times necessary to engage the services of several consulting engineers, or engineering firms, who may be located at various distant points in the United States, it was also necessary to establish a control which would coordinate everybody's activities. This has been accomplished by making the Chief Structural Engineer responsibile for all structural design, the Chief Mechanical Engineer for all mechanical design, and so forth.

In building the Fontana steel plant, very few mistakes were made. There were some but not very many. A railroad track had to be lowered here and there because of insufficient clearance. A crane had to be turned around because the trolley approach had been overlooked. On an average the errors were negligible. Still, the basic design was performed in such widely separated places as Cleveland, Pittsburgh, Chicago, Los Angeles, and San Francisco. But it was all brought together in Oakland.

Development of the Kaiser activities followed a very normal course. When the Kaiser Paving Company established its office in California, it was engaged in highway construction. Sand and gravel is a very essential prime material in paving, so as the next step the company entered into the commercial production of sand and gravel. This was followed by concrete distribution plants. The production of prime construction materials such as cement and steel was a natural consequence.

As has been stated, many years were spent in studies which culminated in the construction of the cement plant and the steel plant. Heavy construction work continued uninterruptedly, as even today the Company is building its own facilities.

SHIPBUILDING—AN OUTGROWTH OF CONSTRUCTION

Transportation of materials was also indicated, and with the acquisition of two cargo vessels several years ago, the Company started shipping. Shipbuilding might be considered as an outgrowth of construction work. At least the problem was tackled as a construction engineer would tackle it. As a matter of fact, a review of the key personnel in the Kaiser shipyards would reveal the fact that almost everyone graduated from Boulder Dam, Bonneville Dam, and Grand Coulee Dam.

Another prime material plant came into being—the Permanente Magnesium Plant. This venture developed into a chemical industry and a brick-manufacturing plant through the natural course of trying to dispose of the by-products.

There is another reason for the speedy accomplishments which are so essential at this time. Start of operation does not wait until the construction has been completed. And the construction always seems to be one step ahead of the design. This seems to be a paradox but it is a fact. Another point is cooperation. This covers both intra-company and outside cooperation. Anyone in the organization who is an expert on any particular subject can always be called upon, and the wholehearted cooperation of consultants in their respective fields has always been enjoyed.

To sum up, the major factors which, in my opinion, permit the widespread activities of the Kaiser organization are decentralization, cooperation, thorough analysis of the problem, application of large doses of common sense, an engineering background, and a competitive spirit. Inner workings of the Kaiser activities are manifold and seemingly unrelated. The common denominator in the organization, is, of course, Henry J. Kaiser. He does not take "No" for an answer.

No Magic Will Prepare Postwar Plans

Responsibility for Completion of Construction Plans Rests with the Individual—Address Presented at the New York Annual Meeting

By G. Donald Kennedy, M. Am. Soc. C.E.

Chairman, Committee on Postwar Construction, American Society of Civil Engineers; Vice-President, Automotive Safety Foundation, Washington, D.C.

In every phase of our military operations, American civil engineers are doing notable work—much of it actually in advance of the combat units. The membership of this profession has furnished skills for the Navy's Construction Battalions, for the Army Engineers and Transportation Corps, and for a host of other specialized services. The operating manpower for these services has been recruited largely from the ranks of the construction industry, including common labor, skilled labor, and supervisory personnel—and these men carried into military service the *esprit de corps* of their peacetime operations.

Aside from the work civil engineers are doing on the fighting fronts of the world, they have made other notable contributions to the war effort—for example, construction plans and supervision for our military establishments here at home and for our great new war factories. They have also performed essential engineering services in the local communities, and have actively participated in the many home-front activities of war.

It has become trite to say that engineers, who plan and build the physical facilities of the civilized world, have a responsibility to put their skill and experience to higher and broader uses—to participate more actively in community and national deliberations which lead to decisions as to what physical facilities should be built and how they should be operated.

ENGINEERS SHOULD ADVISE

In the coming year governmental leaders of the world will make political decisions which will control the disposition of natural resources, the use of minerals, power, communication, and transportation. Within these decisions will lie the potentials of a third world war, or a force for lasting peace. Surely the civil engineers, the mechanical engineers, the electrical engineers, and the other professions which deal with the harnessing of material forces, should advise our world leaders on the decisions soon to be made. This is the program which President Pirnie carried to the leadership of our military and diplomatic services this past year.

The work of the Committee on Postwar Construction of the American Society of Civil Engineers occupies a more limited field in preparations for the future. This Committee is concerned with those necessary physical facilities, both private and public, on which an expanded domestic economy will depend, to win the peace at home after the war is won.

Just as time was required to plan and carry out a tremendous construction and conversion program before war production could reach its peak, so time will be required to plan and carry out a construction and reconversion program before this nation can achieve high production of the goods and services of peace, and raise its living standards to the scale required for the expanded employment which we all agree is our major domestic postwar requirement.

It goes without saying that preparations for the postwar period must not interfere with the stern requirements of the war. That principle has been kept uppermost by the Committee during the two years of its activity. In spite of that limitation, much real progress has been made, and the groundwork has been laid for even greater progress during 1945.

COMMITTEE ON POSTWAR CONSTRUCTION

The Committee was established early in 1943 by the Society's Board of Direction, and the members were appointed by Past-President Ezra B. Whitman. Past-President Pirnie has continued and expanded its activities, and President Stevens now has asked that the Committee continue its work during the new year. The work is based on activities carried out through the Local Sections of the Society. The construction program, public and private, cannot be planned or executed on a national basis. If the job is not done within the local community, it will not be done at all.

All but one of the 62 Local Sections in the United States have local committees on postwar construction in operation, and rather spectacular results have been obtained in some Sections. The groundwork has been laid throughout the nation, and the work is picking up momentum with each passing week.

To accomplish the objective of having the construction industry ready to assume its responsibility toward postwar reconversion and an expanded peacetime national economy, civil engineers should not attempt to establish their own special agencies for postwar construction planning. Rather, they should participate in the work of existing community organizations and official agencies—or stimulate community leaders to set up such postwar planning organizations where they do not now exist.

To open the door for such local relationships with other organizations, the Committee on Postwar Construction has sought and obtained practical working relationships with many organizations, such as the Committee for Economic Development, the Chamber of Commerce of the United States, the American Institute of Architects, the Federal Works Agency, and various national municipal and housing associations, both public and private. As a result of an experiment in Cleveland, Ohio, and Allentown, Pa., which showed how successfully our construction program can fit into the work of the local Committees for Economic Development, President Pirnie was invited to serve as chairman of a C.E.D. Action and Advisory Committee. The Society's Committee on Postwar Construction now is working with local C.E.D. committees throughout the nation in fitting its work into the C.E.D. program.

The McGraw-Hill Publishing Company has made available to the Committee its Business News Department reports under the supervision of Miss Elsie Eaves, Assoc. M. Am. Soc. C.E. This is a service of *Engineering News-Record* magazine. The management of this magazine, and of *Construction Methods* magazine, has rendered special assistance to the program. Vincent Smith, associate editor of *Construction Methods*, has

served first as director of our committee staff and more recently as special adviser working with Director Mark Owen.

FIFTEEN BILLIONS OF PLANNED CONSTRUCTION

The objective is to see that preparations are completed before the war ends for 15 billion dollars in construction for the first postwar year. Of this amount, two-thirds should involve private residential, commercial, and industrial construction, and one-third public works. This total is necessary, on the basis of past records, if construction is to do its share of the job of maintaining the 140-billion-dollar postwar national income which the C.E.D. declares will meet employment needs.

At the moment, only a half billion dollars' worth of construction is ready for postwar letting. Considerable progress has been made in the last year in getting engineering plans under way, so that the total volume now in the design stage is approximately six billion dollars. Most of the total now ready for bids, or in the design stage, is for public works. Industrial and commercial construction plans, as measured by reporting services, are lagging seriously. The residential volume, which must cover half of all private construction, is generally non-engineered construction, and therefore at present it is not possible to measure progress reliably in the residential field.

During 1945, preparations for private construction must be stressed. Public works planning is moving well, and recent federal legislation on general public projects and postwar highways will add new impetus to this movement. But public works make up only a third of the construction field. If private construction activity fails to get under way quickly at the end of the war, engineered public works cannot possibly take up the slack. There is grave danger of a new WPA if construction preparations continue to move so slowly.

A realization of the key role of private and public construction in the reconversion period has been expressed by such organizations as the National Association of Manufacturers, the Committee for Economic Development, and the U. S. Chamber of Commerce. Through the relationships with business, government and professional organizations developed by the Society's Committee on Postwar Construction, the door is open to intensive local activity by our membership, in bringing home to private investors the need for advance completion of plans for commercial, industrial, and residential developments.

While general indications are that a tremendous home-building and industrial construction program is possible, progress reports on construction planning throughout the nation point clearly to a dangerous lag in preparations for this private work. Much of the industrial phase is kept secret because of competitive relationships. But the war has strengthened the decentralization trend of industry and residential areas, and this trend will certainly bring large volumes of new construction in the future. To benefit the postwar economy, private construction activity must begin on time.

PRIVATE INVESTORS MUST KNOW

Many private investors fail to realize that it generally takes longer to prepare for construction than to carry out the actual building operation. It is up to engineers who know the pre-construction problems fully, to bring this fact home to local business men, community associations, and local public officials.

When we realize that nine million Americans worked on construction and maintenance projects in 1940—including both on-site work and work in private industries supplying materials and equipment—we see that, with their families included, these construction workers are directly responsible for the economic well-being of 30 million Americans, or nearly a quarter of our total population. The new factories and homes, and transportation and communication facilities, provide the physical plant that generates the production and living standards of the whole nation.

But it takes time to plan and design these facilities and to acquire land for them, arrange their financing and remove legal obstacles. When those preparations are completed, the construction industry can go to work. Civil engineers, whose work it is to prepare the plans and specifications for construction, have a patriotic obligation to advise and stimulate those who make the decisions—the governmental agencies and the communities and the private investors. If we who know the pre-construction problems fail to accept this obligation in our own communities, where these problems lie, we cannot expect those who lack our type of training to understand the job we were trained to do.

The work begins at home. Have we planned a new house, or garage, of our own? Have we arranged for the architectural work, and picked the site? Then look at our own neighborhood. Does it need a better sewer line, or a street repair job? Does our community need a sewage plant, or an express highway? Does a local factory, or a merchant, intend to have a new building after the war, or to modernize his present structure?

After looking over the local situation, and encouraging our neighbors and local government agency to do likewise, we can turn to the county and state. It is these many local projects which add up to an important total nationally. The Boulder Dam's and TVA's of the Federal Government make news, but the record shows that they are insignificant in the total construction picture.

RESULTS DEPEND ON INDIVIDUALS

There is no magic formula for getting postwar construction preparations done. The Society's Committee can and does offer a list of suggestions for activities by Local Sections, and can arrange for joint relationships with business and professional groups locally. But results depend entirely on community action in applying those suggestions to fit local situations. And the Local Section in turn must depend on individual engineers.

In his own city and state, meeting his wartime responsibilities, and working with community organizations to stimulate preparations for postwar resumption of the building of needed public and private physical facilities, each individual engineer can make the greatest possible contribution to the whole nation. I want to urge engineers to read again the statement of policy on "Postwar Construction" (CIVIL ENGINEERING for September 1943, page 439) which is the basis of our Committee activity. Then they should study the Local Section activity program, and see how they personally can best devote energy and intelligence to the carrying out of that program in their own communities.

Engineers generally know a lot about what their local community needs, and they know how to plan on a practical basis to meet those needs. Nobody else is so directly affected by the level of construction activity as is the civil engineer. Let us, in this stay-at-home year, in addition to meeting our wartime responsibilities, take on in full our individual responsibility for helping our community, our country, and our state, prepare for postwar construction. The job is yours!

Ore for War Moves by Rail from Mesabi Range

By William B. Irwin, M. Am. Soc. C.E.
Assistant to Vice-President, Great Northern Railway, St. Paul, Minn.

STEEL—it is impossible to imagine a modern army without it. Obviously the first step in getting bazookas and 'dozers into the hands of our fighting men is to get iron ore out of the earth and into the blast furnaces. The largest part of U.S. ore comes from the northernmost states, particularly the Mesabi Range in Minnesota. But this region is remote from the centers of steel manufacture. The first step in the transportation chain —that by rail from the mines to the lake freighters—is described by Mr. Irwin in this paper, which was presented at a meeting of the Northwestern Section.

PRODUCING the quantity of steel required for our own and allied forces is one of the most portant of wartime problems. innesota supplies more than two-irds of the iron ore mined in the nited States. Many engineers are miliar in a general way with the e-mining operations on the Me-bi Range, and have seen the enor-ous open pit at the Mahoning ine near Hibbing, and various her open-pit operations in that vi-nity.

Extensive railway operation is in-lved in handling ore from the nge to the docks on Lake Superior, and in providing e necessary dock service for shipment by boat to the rnaces at the Lower Lake ports. The Great Northern cks are at Allouez; the Northern Pacific dock is at perior and is used also by the Soo Line for ore hauled om the Cuyuna Range; and the Duluth, Missabe and on Range, which serves both the Mesabi and Ver-illion ranges, has docks at Duluth and at Two Harbors. ee Fig. 1.)

The largest part of the tonnage shipped from Min-sota mines is handled by the D.M. & I.R., which hauls e U.S. Steel Corporation ore. In 1942, the year of the rgest shipments, 75,300,000 tons of ore was shipped om Minnesota—70,280,000 tons from the Mesabi Range. is estimated by the Department of Mines of the State Minnesota that there remain on the Mesabi Range pproximately one-half billion tons of open-pit direct e, and around 300,000,000 tons of underground direct e, together with a very large quantity of taconite, hich is under investigation to de-elop a lower-cost method of concen-ation against the day when the supply high-grade ore is exhausted.

Most mining on the Mesabi Range of the open-pit type, although there e some year-round shaft operations here ore is stockpiled during the osed season of lake navigation and aded out by power shovels. In open-t operation, most of the ore is loaded y large electric shovels in the pit rectly to cars which the mining com-ny hauls to the surface, or the shovel ads ore into trucks which haul it to e surface and dump it into ore cars, hich are dropped beneath the load-g ramp by gravity. The latter prac-e is growing as it avoids the purchase pit locomotives and track material, d the maintenance of trackage, by e mining company. Also it releases nches of ore which would otherwise e required for track embankment from t to surface. Some mines are using lt-conveyors from pit to surface. The railway company takes delivery of the ore at the surface and furnishes surface trackage from the top of the grade.

During the winter months, the railroad carries out preparatory work for the next season's operations. Trackage is constructed for newly opened mines, or rearranged for mines previously operating. Cars and locomotives are overhauled and general repairs are made at the docks.

In the war years, when steel production has been of such great importance, special attention has been given to the early opening of the navigation season. The U.S. Government has furnished ice-breaker service to open the St. Marys River and the Soo Canal. Ice conditions govern the beginning of shipment of Mesabi ore, which is almost exclusively a lake and rail movement. The U.S. Weather Bureau issues an "Ice Report for the Great Lakes" beginning early in March. The railroad begins supplying cars for loading ore at the mines when the ore boats leave the Lower Lake ports for their first cargo. The earliest date of shipment of ore from Allouez was March 27, 1942, when ice still remained in slips, requiring the services of a tug to break it so that the steamer *Ishpeming* could berth at the dock for loading. The last cargo left Allouez on December 5, making a 254-day season of navigation in 1942.

That section of the Mesabi Range served by the Great Northern Railway—to the operations of which this article is confined—lies 100 miles northwest of Duluth and is about 50 miles in length, the ore-assembling point being at Kelly Lake, Minn., where there is an engine

Great Northern Railway Photo

Loading Cars Directly from the Pit with a $13^1/_2$-Ton Shovel
Mahoning Mine, Hibbing, Minn.

Great Northern Railway Photo

LOADING ORE FROM WASHING PLANT AT BUTLER BROTHERS MINE NEAR NASHWAUK, MINN.

terminal, train dispatcher's office, and a train yard of 2,588-car capacity. Transfer trains operate from gathering points on the Range to Kelly Lake, with auxiliary assembly yards at Nashwauk, Calumet, and Canisteo. Ore trains run directly from Canisteo on the west end of the Range to Allouez via Gunn. The main route for loaded ore trains is from Kelly Lake to Allouez via Casco, 101.66 miles. Ore trains all operate as extra trains on straight running orders. The average length of haul from the 68 mines served directly in 1942 was 110.5 miles.

TRACK AND STRUCTURES

The grade is favorable for the loaded ore trains, being only 0.2% adverse to loaded movement, with a total eastbound rise of 170 ft. There is a heavier grade against the empty trains which run via Swan River, the maximum being 1.16% adverse for a half mile at State Line. Elsewhere the ruling grade westbound is 1%; and the total westbound rise is 997 ft via Casco and 1,056 ft via Gunn. Particular attention has been given to avoidance of abrupt changes in grade. Sags and summits have been ironed out by easy vertical curves to prevent run-ins and break-in-two's of heavy-tonnage trains. Curvature on the ore lines is limited to 5° with three exceptions, of which the maximum is 7° 36′ east of Saunders. The average curvature per mile is 27° 58′.

Rails on the ore lines are 90-lb to 130-lb, fully tie-plated with heavy plates, equipped with rail anchors, and fully ballasted with not less than 4,000 cu yd per mile of processed gravel or mine tailings. There are 3,250 hardwood ties per mile, size 7 in. by 9 in. by 8 ft 6 in., of which 85% are treated, generally by the creosote-petroleum process. Ore lines are double-tracked and block signaled from Swan River to Allouez, except for a one-mile stretch of single track from Saunders to Nemadji River.

Water stations include wayside treating plants of sodium-aluminate type to prepare the water by internal treatment for use in the locomotive boilers. Electric air compressors have been installed at three points on the Range to save the 30 min per train required for a locomotive to pump air for the braking system.

The yard at Allouez includes an engine terminal, an ore-steaming plant, and a yard of 9,198-car capacity, consisting of receiving yard, classification yards, empty departure yard, and repair track facilities with double-track hump equipped with twin automatic scales of 250,000-lb capacity. Yard and docks are flood-lighted.

The four docks, equipped with four tracks each, contain 1,352 pockets with a total capacity of 441,800 gross tons of ore. Docks 1, 2 and 4 are of steel and concrete construction; No. 3 is of timber construction. Docks are from 1,868 to 2,272 ft long, exclusive of approaches. Dock pockets have an average capacity of 326.77 gross tons or 5 carloads of ore. The spout-lowering mechanism is motor driven, and bin bottoms are reinforced concrete slabs. The track level of the docks is from 75 to 81 ft above Lake Superior. The docks are so constructed that the pocket spacing corresponds with the spacing of vessel hatches to facilitate boat loading. The slips are dredged to a depth of 24 ft.

Several classes of motive power are used in the various phases of ore service, but all are steam locomotives burning Eastern coal from the Pittsburgh district, which was brought back in some cases as return loads by the ore boats. The locomotive setup in 1942 was as follows: In gathering and transfer service on the Range, 28 locomotives varying in tractive power from 45,063 to 95,500 lb; in road-haul service, 11 Mallet locomotives, which will be more fully described later; in Allouez yard service, 15 locomotives of 58,500-lb tractive power used for switching, humping, classifying and shoving cars onto docks—a total of 54 locomotives. The road-haul Mallet locomotives are Class N-3, with 2-8-8-0 wheel arrangement, 63-in. drivers, a tractive power of 108,400 lb, a boiler working pressure of 275 lb, and a weight on the drivers of 459,200 lb. The weight of the engine and tender loaded is 854,600 lb and the capacity of the tender is, for coal, 24 tons; and for water, 21,500 gal. These engines averaged 47,316 miles of service during the $8^1/_4$-month ore season, the assignment being a round trip per day. All engines of this class are now being equipped with roller bearings on driving journals and with mechanical lubricators for pedestals and hubs.

Ore cars are of steel construction, 24 ft long, of 150,000-lb capacity, and weigh 42,375 lb. They have a single

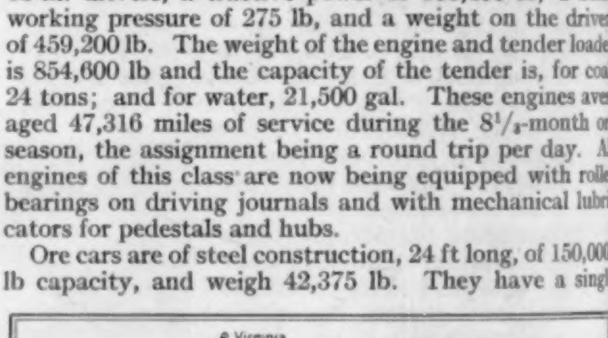


FIG. 1. VARIOUS ROUTES VIA GREAT NORTHERN RAILWAY FROM MESABI RANGE TO ORE DOCKS AT ALLOUEZ, ON LAKE SUPERIOR

...Northern Railway Photo

Largest and Most Modern Iron Ore Docks Are These at Allouez, Wis., on Lake Superior

...pper, a wheel base of 20 ft 2 in., and journals 6 in. by ... in. There are 7,297 of these cars in service, which ...ul an average of 63.67 gross tons per trip. Some cars ...f 100,000-lb capacity are still in service, but they are not ...ndled in solid trains with the large cars.

RAILROAD SERVICE IN HANDLING ORE

The railroad's service begins on the surface at the point ...f depression of an open-pit mine on the Range, and ends ...ith the discharge of ore from dock pockets into the ...old of an ore-carrying boat at Allouez. During 1942, ...ere were 68 mines served directly by Great Northern ...ackage, and exchange ore was received from 43 other ...ines, resulting in the transportation of 27,463,521 gross ...ns of ore from the Range to the docks. There is some ...terchange of ore at Saunders and Allouez, so that the ...uantity hauled from the mines does not coincide with ...e quantity shipped from the docks. The latter amount ...as 28,717,689 gross tons in 1942.

During the 1942 season, 2,349 ore trains were operated, ...ith an average train tonnage of 16,339 gross tons, mak...g the round trip of 220.8 miles in 10 hours 20 min, as ...ompared with 24 hours 56 min in 1913 with a train of ...,122 gross tons. The ore tonnage handled per train in ...942 was 11,337 gross or 12,697 net tons. When an empty ...e train arrives at Kelly Lake, the engine is hooked up ...o a loaded, made-up train on which the air test has been ...ompleted, and pulls out for Allouez. There is no traffic ...ut loaded ore trains on the Casco Line, hence no train ...terference, and the first stop—for water—is made at ...rookston, where the ore train enters the double-track ...ain line, making the loaded trip in 5 hours 37 minutes. ...n July 1941, there were handled 299,782 gross ton-miles ...er train hour.

In 1942 the average empty trip was made in 4 hours 43 ...in to Kelly Lake, whence the empty cars are distributed ...o the mines by the transfer and gathering crews that ...ring the loaded cars in to the assembly point. The turn...round time per car required for the round trip between ...he mines and the docks averages 3.10 days for the season.

GRADING AND BLOCKING ORE

Exact grading of ore is a factor in marketing to as...ure a constant chemical and physical structure at the ...urnaces for equalized burdening. There are more than 60 grades of Mesabi ore, as determined by the differing iron content as well as by the presence of other constituents such as alumina, manganese, phosphorus, silica, and moisture. No grading is done at the mines, the ore being loaded just as it comes from the pit. This makes it necessary to establish grades en route so that the ore can be unloaded into the proper block at the dock. Samples are taken from the loaded cars at the mine and the analysis is generally made while the car is in transit to Allouez. The grade is telephoned to the dock and is there recorded on the waybill, which has accompanied the train.

A block number is assigned for each vessel's cargo and the mining company notifies the dock to what cargo individual carloads are to be assigned. The cars are then classified to permit dumping into specified pockets. A great deal of mixing is done to obtain the desired iron content of a cargo, and the more mixing, the more switching is necessary to sort out the required grades, especially when the grade is not received for some cars until after they arrive at the Allouez yard. There was a case in which ore for one cargo was hauled from the mines in 28 different trains.

ASSIGNING AND CLASSIFYING CARS

Individual waybills are made at the mine for each car of ore; the "consist" of the train is wired or telephoned to the dock; the mines assign the cars to various blocks according to the grade determined, each block being numbered and representing one vessel cargo; the train dispatcher notifies the yardmaster at Allouez of the expected arrival time of the ore train; and the towerman at Saunders hands up a message to the engineer, instructing him what track to pull in on at Allouez. Each receiving track is long enough to hold an entire train. The waybills are carried by the head brakeman, who delivers them to the yardmaster, arranged in the order in which the cars are situated in the train.

As the ore moves forward from the receiving yard, the yardmaster prepares a cut list, indicating the cars assigned to each block and the track on which such cars are located. The cut list is supplied to the hump foreman and the switchtenders to inform them what ore is coming off the hump and the classification tracks to which it is assigned. The hump foreman cuts off cars

Great Northern Railway Photo

ORE CLASSIFICATION YARD AT ALLOUEZ DOCKS

for the various ore blocks and advises the car rider to which track the cars are assigned and whether the track is clear or occupied by other cars. Cars are weighed in motion while passing over the hump, at the rate of 3 cars per minute, and the gross weight is automatically stamped on the waybill.

COMMUNICATION SYSTEM

There is a direct carrier telephone circuit from Kelly Lake to the dock office at Allouez, to which no intermediate stations are connected. There is also a direct telephone line from Kelly Lake to the dock, to which the agent at the scale house is connected, and there are two telegraph wires from the Range to the docks. A one-way voice-communication system of the carrier-current type is used by the hump foreman for giving instructions to the engineers working in the hump yard for better control of yard operations. This system is a valuable aid when visual signals are obscured by smoke or by the frequent fogs in the area. Voice instructions are acknowledged by whistle signals. There is a twin-phone inter-communicating system on the docks, enabling the office to contact foreman, electricians, and other employees at various locations on the docks, and also to inform the masters of approaching vessels at which points along the docks their boats are to be berthed.

STEAMING PLANT AND DOCK OPERATIONS

Many seasons ore is loaded in freezing weather, both spring and fall, and a frozen crust several inches thick forms on it. This crust must be thawed before the ore can be dumped by gravity. An oil-fired steaming plant with two 500-hp Keeler-type boilers, capable of thawing about 800 cars of ore per 24 hours, has replaced the battery of six steam locomotives which formerly provided steam for this purpose. The quantity of ore steamed obviously depends on weather conditions.

In 35 of 42 years some steaming was required before the close of navigation, and in years when ore handling is started early, some steaming is done in the spring as well. More than a million tons were steamed in 1942, thus increasing the quantity available to the furnaces by providing an additional cargo for some vessels before the season closed.

Shove engines of 0-8-0 wheel arrangement (58,500-lb tractive power) pushed 462,320 cars of ore from the classification yards up onto the docks in 1942, requiring 7,072 yard engine shifts. There are usually from 500,000 to 600,000 gross tons of ore in the docks or in loaded cars to supply cargo needs. Gas-electric wrenching machines facilitate the unlatching and latching of hopper doors on the cars to expedite dumping. If ore is wet or sticky, so that it does not flow freely, punching machines, consisting of jackhammers supplied by portable air compressors, are used to start it running.

The docks operate three shifts a day, seven days a week, throughout the season of navigation and are emptied at the close of the season to enable annual repairs and overhauling during the winter months.

Ore-train service and yard and dock operations at Allouez are closely co-ordinated with vessel service, and are governed largely by the supply of boats available. The all-time record for tonnage loaded at the Allouez docks was made in the 24-hour period ending at midnight on June 19, 1944, during which period 22 boats were loaded with 266,804 gross tons of ore. A record cargo was taken by the freighter *Lemoyne* on July 30, 1942, consisting of 17,250 gross tons. In 1942 there were 2,813 boats loaded at the Allouez docks with an average cargo of 10,209 gross tons. Boats spent an average time of 5 hours 54 min at the docks, and their actual loading time averaged 2 hours 46 min. The remaining time at docks was used in pumping water ballast, shifting the boat, and trimming the cargo.

In 1943 there were 323 Lake ore freighters in service under the United States flag, including a number of small boats which probably would not have been in use if the need for vessels had not been so great. The average capacity of all the vessels in use was 9,316 gross tons, although more than 100 exceeded the 10,000-ton average, and the new vessels averaged 12,000 gross tons. There was an average of 11 vessels berthing at Allouez per day during the 1942 season, and they carried 31% of the total Lake ore shipments from Allouez.

The ore service organization is a part of the Mesabi Division operating organization normally comprising about 4,000 employees, with division headquarters at Superior, Wis. In addition to the division superintendent, assistant superintendent, and chief dispatcher at Superior, there are a trainmaster and a chief dispatcher at Kelly Lake and a dock superintendent at Allouez. Most of the supervisory force, the train, engine and yard men, mechanical and dock employees in ore service, have had many years of experience in handling ore. The result is efficient coordination of effort and an excellent record for safe performance.

The iron-ore service is a sequence of operations which manufactures transportation on a mass-production scale by assembly-line methods through the medium of mines, railroads, docks, and vessels. These operations have been developed through more than 50 years of experience, and the practices in use today are the result of that experience, combined with the most modern facilities.

Airfield Layouts

As Influenced by Loadings, Prevailing Winds, and Traffic Volumes

By W. E. Robinson, M. Am. Soc. C.E.
Colonel, Corps of Engineers, U.S. Army

In the course of recent construction of numerous military airfields, considerable experience has been gained in general layout and design. A greater share of all military airfields have been designed and constructed by engineers of the Army. Drawing on this experience, Colonel Robinson has set forth conclusions regarding distribution of loads and traffic, and related problems.

PROCEDURES in use by the Corps of Engineers, U.S. Army, in the design and con-ruction of airfield pavements on ilitary airfields in the continen-l United States have apparently en based on theory and accepted actice in the highway field. This as made necessary by the urgency the situation and the speed with hich airfields had to be constructed order to make them available to meet the rapid ex-nsion of the Army Air Force. It is believed that in e future a more rational approach can be made to the oblem of design of military airfield runway layouts d the design and construction of military airfield vements.

DISTRIBUTION OF AIRPLANE LOADS ON MILITARY AIRFIELDS

The distribution of loads for which runways, taxiways, d aprons at military airfields have been designed has en handled empirically because of the lack of factual ta bearing on the problem. Runway pavements have nerally been designed for a certain number of daily petitions of the loads created by an airplane of a speci-d size and weight, and to this 25% has been added for xiways and aprons. This approach to the problem sults in all parts of all run-ays being designed for the me load, and all parts of aprons d taxiways being designed for load 25% greater.

Where airplanes are parked stematically on an apron, they e taxied into place along a arked route and are parked at signated spots. That part of e apron which is used as a mmon taxiway is therefore bjected to the loads of all air-anes moving from parking to ke-off or from landing to park-g. Because of limited area ailable for taxiing, the traffic closely channelized on this rt of the apron, thereby sub-cting it to many repetitions of ads created by airplanes mov-g at slow speed. This part of e apron is also subjected to ads created by airplanes turn-g out of the common taxiway they peel off to a prescribed parking spot, or as they ter the taxiway en route to take-off position. Maneu-ering into parking position creates special loads due to rning; however, the number of daily repetitions of ese loads is small.

On account of their generally narrow width, taxiways e subjected to a channelization of traffic due to the inclination of pilots to move down the center; this subjects a small part of the taxiway to heavy loads created by slow-moving airplanes. The portion of the taxiway adjacent to its intersection with the runways on the apron side is quite generally used for warming up engines. In this operation, when several airplanes are warming up preparatory to taking off, they generally are maneuvered into a position at an angle of approximately 45° with the center line of the taxiway, so that the propeller blast will not be directed into the airplane to the rear. Such maneuvering and warming up creates special loadings on this part of the taxiway. When an airplane taxies on to the runway preparatory to taking off, the slow turning creates unbalanced distribution of load. When airplanes move off the runway on to the taxiway after landing, the turns are generally at higher speeds than those made prior to the take-off, thereby creating an unbalanced distribution of the load, which is different from the distribution occasioned by turning at slow speed.

Runways are subjected to the loads occasioned by airplanes taking off and landing and by incidental movements. When a pilot taxies his plane onto the runway preparatory to take-off, he normally moves at slow speed, lines up with the center line of the runway, applies brakes, accelerates the engine or engines, releases the brakes, and starts the take-off run. In this maneuver the greatest load is transmitted at the take-off end of the runway; this load diminishes until the airplane's wheels are in the air.

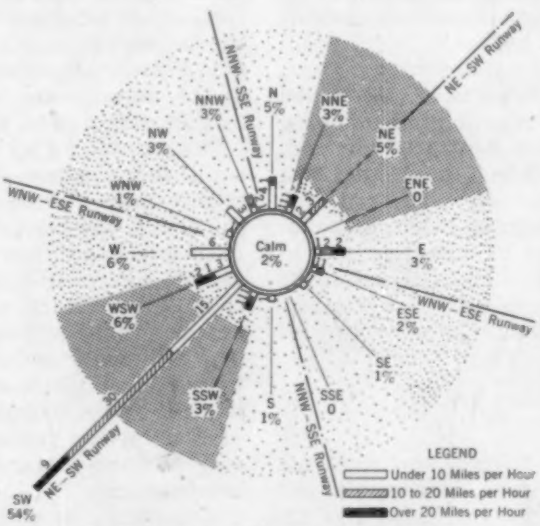


Fig. 1. Wind Rose Prepared from Average of Ten Years' Records—Runway Direction Indicated

When an airplane lands, the runway is subjected to the loads created by the contacts of the airplane with it, the loads occasioned by taxiing, generally at high speed, and the loads occasioned by turning off onto the taxiway. It may be expected that nearly all airplanes when taking off will travel down the middle third of a runway 150 ft wide, and almost as many will use this part of the runway in landing. As previously stated, the end of the runway from which the take-off run is started receives the maximum load. Most landings occur within 1,500 ft of the end of the runway. It is the writer's belief that the contacts of the airplane with the runway on landing do not create the critical loads for which runways should be designed.

Determination of the percentage, distribution, and kind of airplane loads for which a military airfield is to be designed, by the calculation of a traffic flow chart, is be-

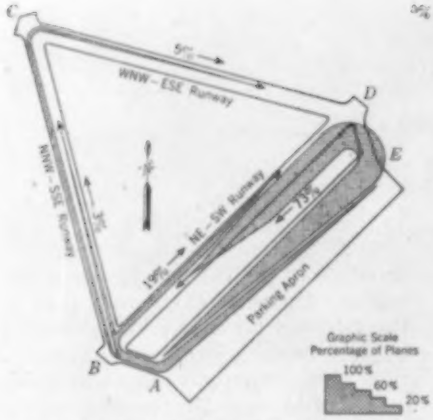


FIG. 2. DIAGRAM OF TRAFFIC FLOW BEFORE TAKE-OFF

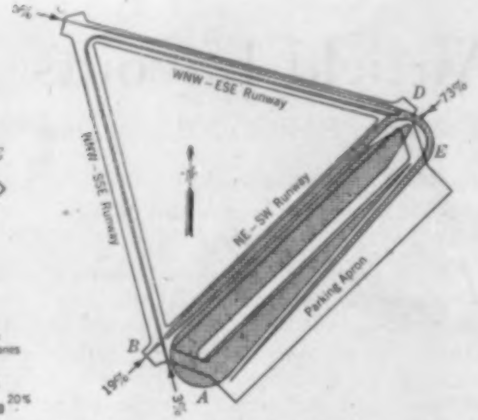


FIG. 3. DIAGRAM OF TRAFFIC FLOW AFTER LANDING

lieved to offer a rational approach to the design of such fields. The traffic flow chart is based on the use of wind-rose data. In developing these, consideration should be given to the effects of cross winds of different velocities on the take-off or landing of the type of aircraft which may be expected to use the airfield. Cross winds up to 10 miles per hour do not seriously affect the landing or take-off of military aircraft. A detailed wind study is one of the first requisites in the design of a military airfield. This study should include the preparation of the following wind roses in so far as they are considered necessary and can be made available:

1. A ten-year wind rose based on hourly readings showing direction, percentage, and velocity of all winds to 16 points of the compass, with directions and percentages to include calms, winds of zero to 5 miles per hour, 5 to 10, 10 to 20, and above 20 miles per hour. All wind roses should have a division of velocities at the point where cross winds are considered to seriously affect the landing and take-off of the type of aircraft for which the airfield is to be designed. In the case of military airfields this is assumed to be 10 miles per hour.
2. A low-visibility wind rose.
3. A ten-year wind rose as specified in (1), developed according to the seasons of the year if predominating seasonal winds above 10 miles per hour are indicated, and if the operation of the airfield is to be limited to a part of the year.
4. If a consistent, marked difference between the direction and velocity of winds over 10 miles per hour in hours of daylight and of darkness is indicated, and if the airfield is to be used mostly for daylight or for night operations, then separate wind roses should be developed for each of these periods of the day.

DEVELOPMENT OF AIRPLANE TRAFFIC FLOW CHART

The airplane traffic flow chart offers a new approach to the determination of the percentage, distribution, and density of airplane loads to which the various parts of the runways, taxiways, and aprons of a military airfield are subjected. Starting with the wind rose, illustrated in Fig. 1, and the airfield layout, the traffic flow chart may be developed.

The principal and most accessible runway, laid out to conform to the direction of the prevailing winds above 10 miles per hour, is the NE/SW. All military airplanes will normally use this runway, or could do so with safety, under the following conditions: when the winds are NNE, NE, ENE, SSW, SW, WSW; when winds from other directions are less than 10 miles per hour; and during periods of calm. From the wind rose it is determined that 92% of all landings and take-offs would be on this runway; that of these, 73% would be toward the southwest, and 19% toward the northeast. The second most used runway for landings and take-offs is the WNW/ESE. Military airplanes will normally use this runway when winds from the W, WNW, NW, E, ESE, and SE are in excess of 10 miles per hour. From the wind rose it is determined that 5% of all landings and take-offs from this airfield will be on this runway and that all of these will be toward the ESE. The least used runway, in percentage of landings and take-offs, is the NNW/SSE. Military airplanes will normally use this runway when winds from the NNW, N, SSE, and S are in excess of 10 miles per hour. From the wind rose it is determined that 3% of all landings and take-offs from this airfield normally would be on this runway and that these landings and take-offs would be toward the NNW. The 5% of airplanes using the WNW/ESE runway for take-off will use the NNW/SSE runway as a taxiway to get to take-off position. The NNW/SSE runway, as it is used as a taxiway and for 3% of the landings and take-offs, actually is subjected to slightly greater loading than the WNW/ESE runway.

The take-off traffic flow chart, Fig. 2, and the landing traffic flow chart, Fig. 3, calculated as previously outlined, indicate graphically the movement of all aircraft prior to take-off and after landing. A study of these charts indicates that all airplanes taking off or landing will taxi along the common taxiway portion of the apron, that 73% taking off will use the taxiway *ED*, and 27% the taxiway *AB*; and that 5% of the planes taking off will taxi down the NNW/SSE runway from *B* to *C*. On landing, 73% of the airplanes will use the taxiway *BA*, and 27% the taxiway *DE*; 3% will taxi on the runway from *C* to *D*. The directions and percentages shown at the ends of the runways are for the landings and take-offs that may be expected on each.

The practical applications of well-formulated airplane traffic flow charts to problems arising in connection with maintenance and reconstruction of existing fields, and the design and construction of new ones, are numerous. In the maintenance or reconstruction of an airfield, a study of such charts will indicate the amount and type of traffic to which the various parts of the runway system are subjected and thereby provide a means for determining the urgency and priority of repairs or reconstruction to be accomplished, and the possibility of rerouting traffic during reconstruction. This study may show that certain runways or taxiways are surplus, in which case they may be given a standby status and used for emergency landings only.

The wind rose and flow chart offer excellent information for use in developing standard operating procedures for military airfields. In the design of new airfields, an exhaustive study of the wind rose and traffic flow charts for various runway layouts will permit selection of the most efficient layout from the standpoint of design, construction, maintenance, and operation, permitting if desired the construction of the minimum facilities necessary for accomplishment of the mission. In addition to the practical applications of the wind rose and traffic chart mentioned, there are many other applications in connection with the design and construction of military airfields.

Flood Abatement by Headwater Measures

By Howard L. Cook, M. Am. Soc. C.E.

Office of Water Utilization, War Food Administration, Washington, D.C.

ALTHOUGH it is the havoc done by great main-river floods that is most prominently featured in the news, a large percentage of all flood damage is caused by small, frequent floods on headwater streams. In reducing this widespread damage to land and crops, land treatment has been shown to be effective. Such measures have relatively slight effects on major floods in main rivers and must supplement—not displace—downstream control works. The following is a condensed version of a paper presented by Mr. Cook before the St. Louis Local Section of the Society.

FOR many years prior to 1936, controversy raged over the ability of reforestation, soil nservation, and similar measures reduce flood runoff—some exmists claiming that they affected ods not at all, others contending h equal vehemence that by oper treatment of land, floods ld be entirely eliminated. The nnibus Flood Control Act of 36, authorizing the Secretary of riculture to investigate the effect such measures upon floods, did a at deal to dry up the sources of s controversy by making possible drologic and economic studies of unprecedented scope d intensity.

The results of some of these studies are now available d are of considerable public interest, for it has bene quite clear that flood control is to play an imporit part in the nation's postwar public works program. blic opinion will ultimately establish the nature of our tional flood control policy; it is therefore most imrtant that the public be fully and correctly informed. is particularly essential that civil engineers be well formed, for they have a special interest in flood conl and exercise a powerful influence on public opinion.

When most people think of floods they visualize great ers, like the Mississippi, the Missouri or the Ohio, erflowing wide valleys, driving people from cities and ms, causing enormous damage, and often taking any lives. This is only natural because these great ods are spectacular and claim the headlines of our ily papers. But there is another flood problem that is t called to public attention by newspaper headlines. is problem arises from the vast aggregate damage used each year by the frequent flooding of the myriad adwater streams draining our broad agricultural reons. Such damage occurs on minor tributaries that ain anywhere from a few to several hundred square les. The result is mainly the deuction of crops on fertile bottomnd fields, damage to agricultural operty, and the deposition of sedient in channels and on flood plains. This is the headwater flood problem. ear in and year out, the small headter valleys of agricultural regions e subject to damage that exceeds, in e aggregate, the damage done in ajor valleys. Thus the United States s two great flood problems—the probn of protecting the concentrations of pulation and wealth in its great river lleys, and the problem of abating adwater damage—both to the fullest tent that may be economically justid.

To further clarify the nature of the stream problem, it will be helpful to int out the great differences between ods on large rivers and floods on adwater streams. The great floods that inundate the principal valleys (and do so much damage to river cities) are caused by general and protracted storms, covering wide areas and precipitating great depths of water. Although the rates of rainfall are usually low, the volume is enormous. As a result of such storms, the soil becomes thoroughly soaked and infiltration capacities reach minimum values. Moreover, the thinner soils become saturated and finally can retain no more water. Under these conditions, every small stream over thousands of square miles flows steadily at or above bank-full stage for many days. The tremendous volumes of water moving down through the tributaries pass into the valley of the main stream, filling it like a great trough into which water is poured from both sides. Runoff causing floods like these is, of course, affected but little by treatment of the land.

On the other hand, general storms of this sort do not produce extreme floods on the small tributaries. Most of the damaging headwater floods are caused by short rains of high intensity. These floods usually occur on but one or a very few tributaries, and are dissipated in the large channels of the main streams. But they do occur in the growing season when the greatest damage may be done to crops.

Headwater floods are caused by an entirely different type of storm from that which causes downstream floods, and the two types of floods seldom occur simultaneously. They also require different types of remedies. Programs that will greatly decrease flash floods on headwater streams may have little effect on major floods far downstream.

In the humid portions of the United States, floods on small tributaries occur, on the average, several time each year. Most of these floods are caused by intense summer storms. Occurring, as they do, during the growing sea-

Cultivation on Contour Lines Increases Surface Storage Capacity

PROPER MANAGEMENT OF GRASSED LANDS REDUCES RUNOFF AND EROSION TO INSIGNIFICANT AMOUNTS

son, they are highly destructive to crops on bottom lands. In many regions the flood plains of headwater valleys are the most important agricultural land available. Often they constitute the very backbone of the farm economy. In the Midwest agricultural area, the damage done annually by headwater floods averages from two to three dollars per acre of flood plain—not per acre flooded, but per acre of the entire area inundated by the maximum floods. Moreover, in these agricultural regions from 5 to 10% of all land lies within such flood plains. So it is not surprising that the damage done by flood waters in humid agricultural regions averages about $100 per sq mile.

A comparison of these headwater damages with those experienced downstream will contribute toward an appreciation of their true importance. To this end a hypothetical watershed is depicted in Fig. 1. The relative magnitude of the damages assumed for the watershed is based on information obtained in a number of detailed flood control surveys made by the U.S. Department of Agriculture. This basin is assumed to have an area of 10,000 sq miles and the physical characteristics of the great middle western prairies.

It is further assumed that a city is located near the lower end of the watershed and subject to urban damages varying from a few thousand to several million dollars per year. The damage at such a city might average $200,000 annually—an amount fairly typical for the larger river cities of the United States. The average annual damage along the main stem is assumed to be $80,000 and that along the principal tributaries $50,000. These channels are indicated by the dotted line.

Such a watershed would probably contain over 5,000 miles of stream channel in addition to the main stem and principal tributaries. The figure indicates these streams by solid lines. In these headwater valleys an average annual flood damage of about $1,000,000 would be experienced and any major flood control structures that might conceivably be built for the protection of the city and the main valley would not in any way reduce this damage. Thus, in a basin suffering an annual flood damage averaging $1,330,000, the distribution of damage might be approximately as follows:

15%—city damage
6%—damage to the main valley
4%—principal tributary damage
75%—damage in headwater valleys

These damages are those caused by water and do not include the large sediment damages that may also be sustained, nor do they include erosion damage nor damage adjacent to gullies and other sm[all] upland watersheds. In short, they a[re] true flood damages occurring along w[ell] established streams draining siza[ble] areas. It is not generally realiz[ed], however, that in collecting floo[d] damage data these headwater losses a[re] almost invariably overlooked and a[re] therefore not included in estimates [of] damages sustained in a watershe[d]. This means that in watersheds like th[e] one just described, only about on[e] fourth of the total flood damage is ord[i]narily reported. In general, therefor[e] estimates of the damage done by flood[s] within the United States are much to[o] small.

Nearly all agricultural damage i[n] headwater areas is caused by smal[l] frequent floods. This fact has important econom[ic] implications. It indicates that programs which wi[ll] substantially reduce small floods will produce larg[e] benefits, even though their effect on major floods ma[y] be small. To show just how important this fact may be, Fig. 2 has been prepared from data derive[d] from an analysis of flood damages on the East Fork o[f] the Trinity River in Texas, and on Sandstone Creek a tributary to the Washita River in Oklahoma. The chart shows that 30 to 40% of all flood damages i[n] these watersheds are caused by the small floods th[at] occur, on the average, once each year or more often. It also shows that 75% of all damages are caused b[y] floods smaller than the 5-year flood, and only about 5% by the major floods that occur at intervals exceeding 2[5] years.

Another cause of serious damage in headwater valleys is the sediment carried into them during floods. The sediment fills channels, is deposited on fertile flood plains, and is carried into reservoirs. In filling channels, sediment causes damage of two kinds. It increases the water damage by causing more frequen[t]

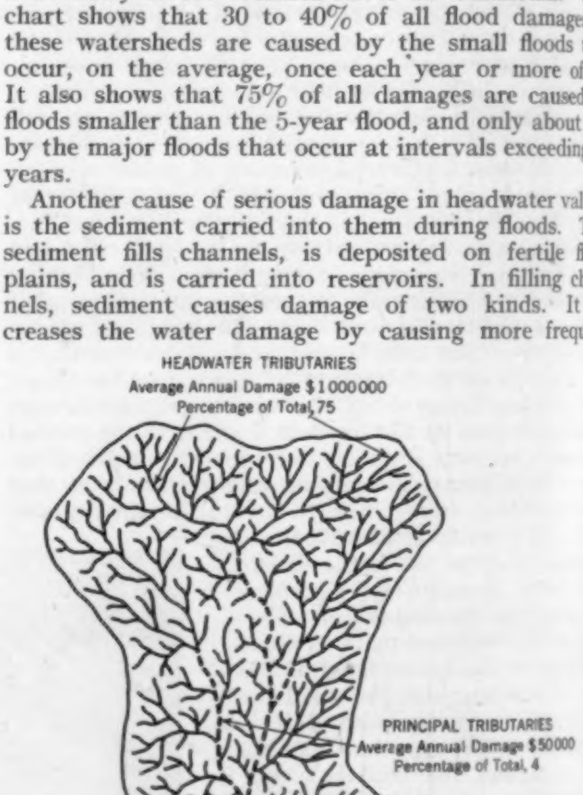


FIG. 1. SHOWING RELATIVE MAGNITUDES OF FLOOD DAMAGES

oding of adjacent fields; and, by raising the water table, it brings about swamping and eventual abandonment of these lds. The sediment deposited on the flood ain also causes serious damage, particurly if upland erosion is progressing rapidly, r under these circumstances the quantis of deposition are so great, and the ality so poor, that eventually productive ttom lands become worthless. Sediment mage to reservoirs is also considerable in me parts of the country.

Sediment damages of the sort described, hile particularly serious in headwater lleys, are also a threat far downstream. uch of the sediment now slowly on the ove through headwater valleys will eventally reach the great river valleys and do uch harm there.

One method of reducing headwater floods to treat the land itself to minimize runoff d erosion. Another is to construct many all headwater reservoirs or ponds. Still another is increase the capacity of headwater channels—a practice often classed as a drainage operation.

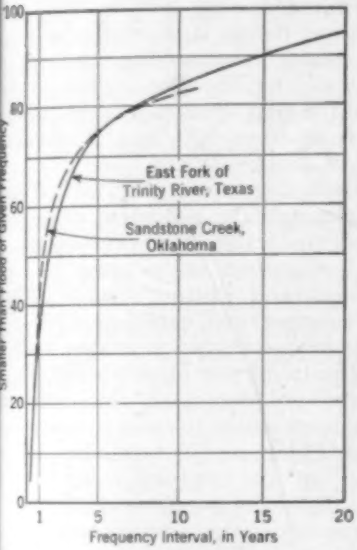


FIG. 2. SMALL FLOODS CAUSE 75% OF ALL AGRICULTURAL DAMAGE

Erosion from the uplands, and thus the sediment contributed to the streams, can be reduced by the same land-treatment measures used to decrease runoff. But where gullies are already formed, they must be stopped—often by means of small structures. Excessive stream-bank cutting must also be controlled. In mountainous watersheds, where erosion cannot be sufficiently diminhed by other methods, debris must be stored behind rriers erected for the purpose.

In the past few years much attention has been given the possibilities of flood and sediment abatement by easures applied directly to the surface of the land—a ethod that is here called, for the sake of brevity, land eatment. It is this kind of a program that has reived the most attention from the Department of griculture under the Flood Control Act of 1936. Indentally, the evaluation of such programs requires the lution of the most difficult problems of the science of drology.

Land treatment does three things. It increases

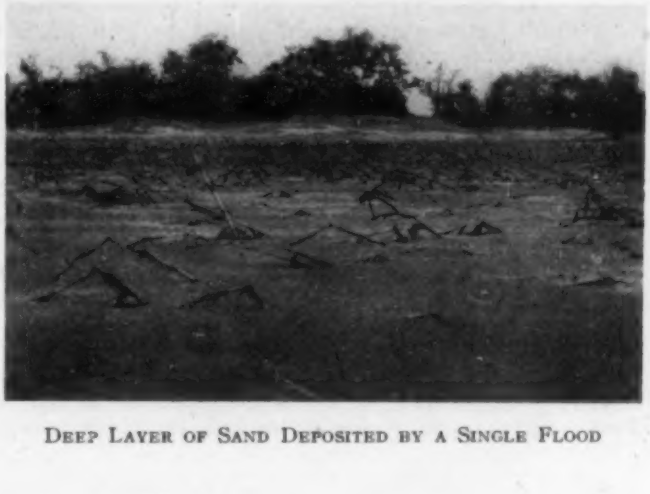
1. *The rate* at which rainfall enters the soil.
2. *The amount* of water stored on the surface of the land during storms.
3. *The capacity* of the soil to store water.

The infiltration capacity of the land is increased by provements in vegetal cover. A land-treatment program therefore places much emphasis upon such measures as pasture and forest improvement, the use of close-growing cover crops on cultivated lands that would otherwise be bare, the conversion of steep cultivated slopes to pasture and forest, soil improvement, fire control, and grazing management. The capacity of the land to store water on its surface is increased by all the measures that improve vegetation and also by mechanical practices, such as contour cultivation and terracing. All the measures mentioned also reduce erosion. But, as previously stated, there must often be added gully control, bank protection, and debris storage.

A HEADWATER CHANNEL ENTIRELY FILLED BY SEDIMENT

THE EFFECT OF LAND TREATMENT

One important point must be established at the outset. The physical characteristics of a watershed do have a powerful influence on the floods discharged from it. One of many comparisons that might be made to prove the profound effect of land characteristics on floods is shown in Fig. 3. The curves show the flood runoff that would be produced, on the average, by a storm of given magnitude. Hell Creek is a tributary to the Little Tallahatchie River in northern Mississippi. It discharges the floods originating on the heavy soils of the so-called "Flatwoods" area. Maple River is a tributary of the Little Sioux in western Iowa and drains a portion of the Missouri Valley loess prairies. A 5-in. storm produces a flood of but little over one inch on Maple River, while on Hell Creek the same storm would produce over $3^1/_2$ in. of runoff. There is no intimation



DEEP LAYER OF SAND DEPOSITED BY A SINGLE FLOOD

EVEN SMALL RAINS PRODUCE FLASH FLOODS AND MUCH EROSION ON LANDS LIKE THESE

here that there is any practical possibility of changing a Hell Creek to a Maple River. But such comparisons clearly refute the contention that soil and cover have no effect on floods. This curious misconception was often propounded during the early days of controversy, and despite the advanced state of the science of hydrology is sometimes heard even today.

Another principle that has been fairly well established for many years is that changes in vegetal cover and cultural practices greatly influence surface runoff. This means that where soils are deep, and their storage capacity consequently great, large flood reductions might be made if it were only feasible to put all the land under a dense vegetal cover. But of course the land must be used for the production of food and fiber, and therefore even on deep-soiled areas the effectiveness of land treatment is limited by the feasible changes in land use. But the possibilities are illustrated by Fig. 4. The

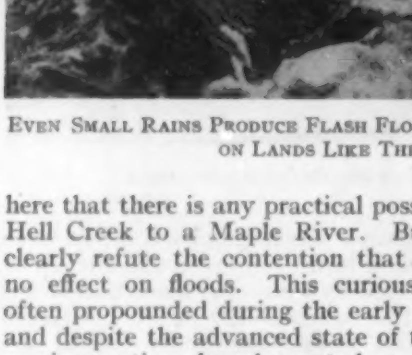


FIG. 3. FLOODS VARY WITH CHARACTER OF WATERSHED

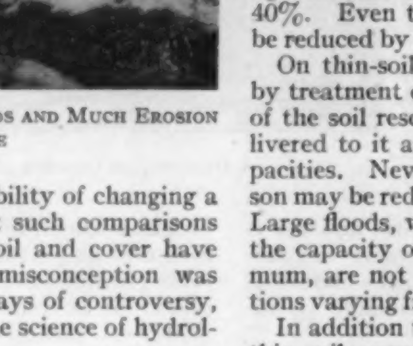


FIG. 4. SURFACE RUNOFF DEPENDS ON VEGETATION

curves show that by a change of land use it is possible to greatly reduce surface runoff. They show the runoff from small plots instead of watersheds. These plots happen to be located on the Piedmont of the Southeast. Because of their small size, all the runoff measured was surface runoff.

It is easy to see that if a bare watershed were placed under a good cover, surface runoff would be practically eliminated. Furthermore, if the floods on this particular watershed were made up only of surface runoff, decreases in flood flows would be spectacular. But there are two good reasons why nothing so sensational can be done. First, there are few watersheds on which sweeping changes in land use can be made; and second, in thin-soiled watersheds, floods are composed of both surface and subsurface runoff. In other words, in such watersheds all the water that infiltrates into the soil during the larger storms cannot be retained or even detained until the surface runoff peak has passed out of the channel system.

What then are the reductions that can be achieved under a practically attainable program of land treatment? On deep-soiled watersheds on which detailed surveys have been made by the Department of Agriculture it has been estimated that such programs will reduce small, frequent floods (and these cause the bulk of agricultural damage) by amounts varying from 20 to 40%. Even the large floods from such watersheds will be reduced by from 5 to 15%.

On thin-soiled watersheds, the reductions obtainable by treatment of the land are minimized by the inability of the soil reservoir to hold all the additional water delivered to it as a result of the increased infiltration capacities. Nevertheless, small floods in the growing season may be reduced by percentages varying from 10 to 3[illegible]. Large floods, which usually occur in spring or fall, when the capacity of the soil reservoir is generally at a minimum, are not substantially reduced, the average reductions varying from zero to 5%.

In addition to reducing floods, land treatment even on thin soils greatly decreases erosion from the land. On the watersheds surveyed by the Department of Agriculture, it was estimated that erosion would be reduced in amounts varying from 40 to 60% by the adoption of practicable programs of land treatment.

An extremely important economic effect of land treatment comes about through the reduction of sediment damages. A decrease in water flow prevents an immediate damage. A reduction in sediment load prevents both an immediate and a future damage. This is because sediment damages are cumulative. For example, as sediment is brought down year after year, the capacity of the channel will be progressively decreased, thus subjecting adjacent lands to more frequent flooding. Moreover, progressive "swamping" of the land will result from the raising of the ground-water levels. In other words, the sediment brought down this year will produce damage in future years. Deposition on the bottom lands works in the same progressive manner and thus also produces future damage.

Land treatment has another important physical effect. It substantially increases the production of farms and forests. It is, in fact, this benefit that accrues to individuals on whose land the treatment is accomplished that provides the incentive which insures the installation and maintenance of the land treatment measures recommended for flood abatement.

The investigations made by the Department of Agriculture under the Flood Control Act of 1936 indicate that there is, in general, no real conflict between programs for headwater flood abatement and programs for protecting large valleys—and the cities in them—by major engineering works. Both kinds of programs are needed. Even where headwater measures have an effect on downstream damages, they do not obviate the need for the downstream works, particularly where human life is endangered by the great storms that may, upon comparatively rare occasions, visit any river basin.

Extend the Life of Concrete Pavements

Hints to Maintenance Men on Patching with Portland Cement

By A. A. Anderson, Assoc. M. Am. Soc. C.E.

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THE useful life of portland cement concrete pavement can be extended almost indefinitely by a well-planned and well-executed maintenance program. Such a program is especially important now in view of wartime limitations. Nevertheless, the procedures outlined by Mr. Anderson will be just as practical at any time, and many have already been adopted as standard practice by highway agencies. The methods described were developed as a result of a study by the Highway Research Board, whose booklet, "Wartime Road Problems, No. 6," deals with this study.

GOOD maintenance, when and where it is needed, serves materially to prolong the life roads and streets of our highway stems. This is true in peacetime, t to a much greater degree during artime. Many of our nation's ads, during the prewar emergency nstruction period and during the ar period, have been called upon carry an increased number of ads in excess of the loadings for hich they were designed. Also ring this period new construction, necessity, has been greatly restricted and many pavements have en required to remain in service that normally would ve been retired or rebuilt. At the same time, many aintenance men have been called into the Services.

For these reasons the difficulty of maintaining pavements in a serviceable condition has greatly increased. nticipating this situation, and to facilitate the war fort, the Maintenance Department of the Highway esearch Board early in the war undertook a study of veral phases of pavement maintenance. One group, pointed by the Chairman of the Maintenance Department, W. H. Root, M. Am. Soc. C.E., Maintenance ngineer of the Iowa State Highway Commission, was signed to the study, "Salvaging Old Pavement—Rigid ype." The committee studying this problem consted of L. L. Marsh, Maintenance Engineer, Kansas ate Highway Commission; C. W. Ross, Maintenance ngineer, Illinois Division of Highways; Rex M. Whitn, Maintenance Engineer, Missouri State Highway epartment; and the writer as chairman.

The first major problem studied by this committee was e replacement of utility cuts and broken areas, comonly known as patching. Such repairs should be made ith concrete so that the patch will be equal in strength d riding quality to the remainder of the pavement. atching should be done at the earliest opportunity. it is delayed, broken areas are apt to become enlarged the action of traffic.

Concrete patches are easily placed. If properly done, e patch becomes practically an integral part of the vement and the patched area is restored to its full efulness, in no way inferior to other portions of the vement. As patching is usually done without closing e road to traffic, methods of handling traffic and proding adequate protection to the worker and to the mpleted patch during the curing period are also volved.

CHARACTER AND CLASSIFICATION OF PATCHES

Determination of areas in need of repair is first necesry. Marking areas involves consideration of the ndition of the existing pavement and the shape and mensions of the patch that will best stand up under affic at each location.

According to the position of the patch in the pavement d for convenience in design details which are pertinent to satisfactory performance in service, patches are classified into five types (see Fig. 1):

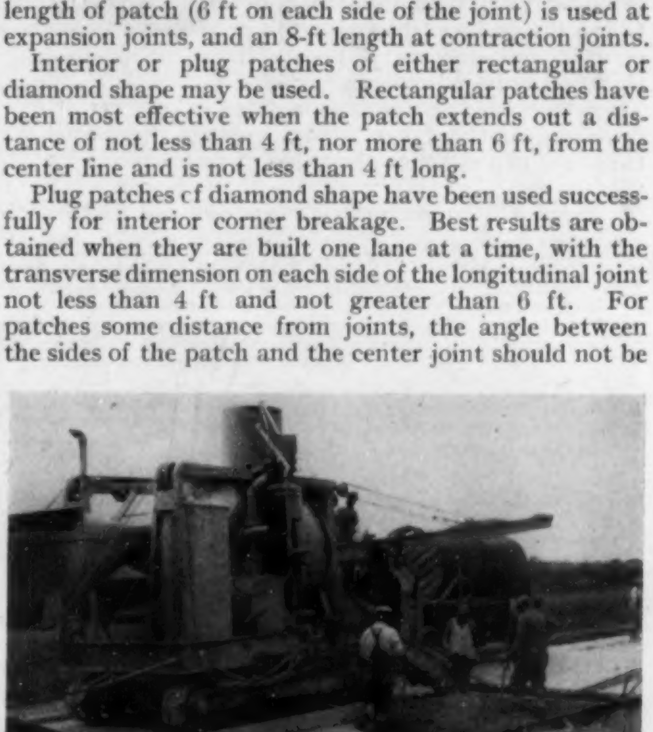
1. Full-width patch, involving all the lanes of the pavement, but usually constructed one lane at a time.
2. Half-width, or single-lane patch.
3. Exterior-edge patch—a patch less than a full lane in width, one edge of which lies along a free pavement edge.
4. Interior-edge patch—a patch less than a full lane in width, with one edge along an interior edge.
5. Interior, or plug patch—this type may be used for breaks which occur on both sides of the center joint.

It is well to note that when a patch is at an expansion joint, the minimum length recommended for it is 6 ft. If there is breakage at both sides of the expansion joint, the total minimum length becomes 12 ft, unless the patch extends for the full width of the pavement, under which condition the joint may be moved to one end of the patch. Except for full-width patches, expansion joints should be reproduced in their original position.

On multi-lane pavements where no median strip is used, it is desirable to maintain the original positions of the expansion joints. In such cases a minimum 12-ft length of patch (6 ft on each side of the joint) is used at expansion joints, and an 8-ft length at contraction joints.

Interior or plug patches of either rectangular or diamond shape may be used. Rectangular patches have been most effective when the patch extends out a distance of not less than 4 ft, nor more than 6 ft, from the center line and is not less than 4 ft long.

Plug patches of diamond shape have been used successfully for interior corner breakage. Best results are obtained when they are built one lane at a time, with the transverse dimension on each side of the longitudinal joint not less than 4 ft and not greater than 6 ft. For patches some distance from joints, the angle between the sides of the patch and the center joint should not be



For a Larger Patch, a 27-E Mixer Is Useful

PREPARATION FOR A HALF-WIDTH PATCH

less than 30 or more than 60 deg. At transverse expansion joints, this angle should not be less than 30 or more than 45 deg. Diamond-shaped patches save concrete whenever they can be used.

It is recommended that patches be of uniform thickness and that dowels and tie-bars be eliminated. The thickness of the patch will be determined to a large extent by subgrade conditions and by the weight and volume of traffic. Where wheel loads do not exceed the capacity of the pavement as a whole, and where unsatisfactory subgrade conditions have been corrected, the thicknesses shown in Table I are recommended for relatively small areas.

Where full-width replacement of pavements of design *A* or *B* (see Table I) involves a length of 50 ft or more, it will be more economical to use the uniform thickness of *A*-2 or *B*-2, and use the *A*-1 or *B*-1 thickness only at expansion joints. These thickened slab ends should be tapered from the *A*-1 or *B*-1 thickness to the *A*-2 or *B*-2 thickness in a distance of not less than 5 ft.

FULL-WIDTH PATCH PLACED ONE LANE AT A TIME

TABLE I. RECOMMENDED THICKNESSES FOR PATCHES

DESIGN OF EXISTING PAVEMENT	DEPTH OF PATCH, D IN FIG. 1
A. Thickened-edge slab	1. D = 1.3 times center thickness of original slab on all patches involving unprotected corners 2. D = 1.2 times center thickness of original slab on all patches not involving unprotected corners
B. Uniform-thickness slab with dowels or other load-transfer devices at expansion joints	1. D = 1.1 times original slab thickness for all patches involving unprotected corners 2. D = same depth as existing slabs for all patches not involving unprotected corners
C. Uniform-thickness slab without load-transfer devices at expansion joints	1. D = same depth as existing slabs for all patches

Longitudinal center construction joints are placed in full-width patches, since it is usually necessary to build the patch a lane at a time to accommodate traffic. In constructing the first half width, it will be necessary to break out enough concrete in the second lane so that a side form can be set. Care should be taken to keep the first-lane patch completely separated from the broken pavement in the second lane to avoid damaging the freshly placed concrete by the vibration and hammering of traffic over the broken pavement. The same procedure should be used in placing rectangular or diamond-shaped plug patches built in one lane at a time.

In all patches except those placed full width, transverse expansion joints or transverse contraction joints should be replaced in the patch at their original position in the pavement. Load-transfer devices across these joints are not needed structurally in the thickness of patch recommended. However, if present in the original pavement and thought necessary to prevent faulting under traffic, they should be placed at joints in the patch.

Transverse expansion joints located in areas to be patched full width may be omitted unless it is apparent that additional expansion space is necessary. Where space for expansion appears to be needed, the joints can be placed at both ends or at one end of the patch, and at such intervals in the length of the patch as deemed necessary. Expansion-joint filler should be of the non-extruding type and about $^3/_4$ in. thick.

Transverse contraction joints should be installed to form slab lengths of $12^1/_2$ to 20 ft in all full-width patches of 25 ft or more in length. All contraction joints should be of the surface dummy-groove type, having a depth equal to one-fourth the thickness of the patch.

If breakage has been caused by pumping action, it may be desirable to provide good subgrade support in the pavement adjacent to the broken area before proceeding with the repair. This may be done by pumping a slurry of soil and cement or other materials under the pavement.

In removing the old slab, the size of the crew and the kind of equipment used depend on the amount and nature of the patching to be done. Hand methods are recommended where patches are few in number and small in area, or are widely separated. The pavement to be removed is broken up by the use of 12 to 16-lb stone sledges. Breaking of slabs may be facilitated by raising one edge with a crowbar so that a small piece of concrete can be placed under it. The edges of the patch are then trimmed approximately to a vertical plane by means of drills and chisels.

Where patches are large, the use of mechanical equipment will save money and expedite operations. Requirements include a portable air compressor, pneumatic pavement breakers, each with about 30 ft of hose, a su

PLACING CONCRETE FROM A TRANSIT MIXER

of chisel and moil point bits, and the usual small ls. Also needed are barricades, warning signs, a ck for transporting equipment and compressor, and e or more trucks for disposing of the broken concrete. rew includes a foreman, two breaker operators, three orers, and one or two truck drivers.

CARE NECESSARY IN TRIMMING

Other types of pavement breakers may be used. One a mobile unit consisting of an air compressor and phammer mounted on a flat-bed truck. The trip-mmer is mounted on a semicircular bed on the rear the truck in such a way that the hammer will swing ough 180 deg. The triphammer, having a face 6 to in. in diameter, strikes about 100 blows per minute d breaks the old pavement into one-man sizes. This aker equipment is used with a portable air compressor d pneumatic breaker unit which outlines the areas be patched, breaks out corners of patches, and trims ges vertical and to a neat line.

Edges of patches should be as straight and vertical as ssible. The sides of rectangular patches are usually

SCREEDING CONCRETE IN PATCH

rallel to, and at right angles to, the center line of the ginal construction, except where bounded by existing cks. In such cases it has been found practical and isfactory to let the patch boundary follow the crack ere the angle with the center line or the edge of the vement is not less than 30 deg.

Special care should be taken to see that the top inch the vertical face of the old slab is as straight and tical as possible, otherwise thin fins will be formed, her in the old pavement or in the patch, which will er spall under traffic. Before placing concrete in the tch, the edges of old slabs must be cleaned free from st, dirt, and loose particles. The edges of the old slab uld be moist but not wet.

UNDERCUTTING OF OLD SLAB TO BE AVOIDED

As a general practice, undercutting of the old slab is t favored as it is difficult to do the work satisfactorily. is not easy to cut a trench under the edge and to fill with new concrete in such a way as to form a firm pport for the old slab. If this is not done extremely ll, the old slab may be weakened rather than strength-d by the underpinning.

Frequently the breakage of the pavement which led the need for repair can be attributed to a local condi-

VIBRATING EDGES OF PATCH

tion of the subgrade, such as frost boils or heave, or numerous other conditions. Obviously, these conditions should be corrected before the patch is placed if repetition of the breakage is to be avoided. In the case of back-filling for utility openings, the work must be done with proper materials and extreme care to eliminate any possibility of settlement.

Poor drainage may be corrected by the installation of suitable drains to intercept water or lower the water table as needed. Unsatisfactory subgrade material should be removed and new material placed and compacted in thin layers. In all cases, whether the subgrade material is new or old, the subgrade should be damp but not wet before the new concrete is placed.

CONCRETE MIXES

All material for use in concrete patches, as well as for curing, should comply with the specifications for concrete pavement materials of the federal, state, county, or city department undertaking the work. Frequently it is desirable to use mixtures that will give higher early strengths than those attained by the mixtures used in regular construction work. This will permit the patch to be opened to traffic sooner and thus minimize inconvenience. A modulus of rupture of 500 lb per sq in. is recommended as the strength at which to open patches, except in cases of emergency when earlier opening and possible damage to an occasional patch is justified. By

APPLYING CURING MEMBRANE TO FINISHED PATCH

SMALL PORTABLE MIXER IN USE FOR A SMALL PATCH

the use of high early strength concrete, it usually will be possible to open patches in 24 to 72 hours, depending on temperatures, the mix, and other conditions.

High-early strength concrete may be produced by the use of:

1. Low water-cement ratios with normal portland cement. This will require the use of an increased amount of cement. For practical reasons, water-cement ratios should not be less than 4 gal per sack of cement.
2. High-early strength portland cement.
3. An addition of not more than 2 lb of calcium chloride per sack of cement with either normal or high-early strength cement.

CONCRETING PROCEDURE

Concrete should be accurately and uniformly proportioned. Usually this will mean that the materials, except water, for each batch are measured by weight. Water is measured by weight or volume, and the equipment used should be checked frequently. Small portable scales are commercially available for use where a central proportioning plant is not used. Measurement of materials by volume may be permitted on small, occasional patches, if the hoppers are carefully calibrated.

Except for small, isolated patches, the concrete should be machine mixed for at least 1 minute. Transit mixing or central mixing may be used for patching if the concrete arrives at the site of the patch in such condition that it can be placed and finished without the addition of more water. Retempering, or the addition of more water, should not be permitted.

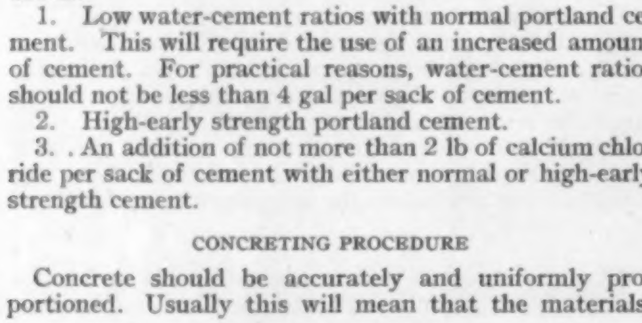


FIG. 1. TYPES OF PATCHES

TAMPING, VIBRATING, SCREEDING, AND FINISHING

The prepared opening should be completely filled with concrete. Concrete shrinks slightly as it hardens, but this shrinkage is minimized by tamping after placement. The concrete as first placed is struck off and tamped to an elevation slightly higher than the finished contour of the patch. Mechanical vibrating equipment is also used advantageously to compact the concrete, especially around the edges of the patch. After delaying as long as possible, while still permitting the surface to be finished, the concrete should be tamped a second time, then screeded, and checked with a straightedge. This insures that the patch will be free from surface irregularities and that it will conform to the contour of the adjacent old pavement.

Best appearance results if patches are finished with a surface texture as nearly as possible like that of the adjacent pavement. This may require the use of a canvas or rubber belt, wood float, burlap drag, or broom, depending on the method used in finishing the original slab. The aim is to produce patches which will harmonize with the surrounding pavement and become indistinguishable under traffic shortly after placement. All transverse and longitudinal joints, and the outside edges of patches, are finished with a regular edging tool. On sides where it joins the broken edges of existing slabs, the patch need not be edged. Satisfactory curing for concrete in patches may be obtained by the use of standard methods specified in federal, state, county, or city specifications.

DIVERSION OF HIGHWAY TRAFFIC

Provision must be made for the handling of traffic and the installation of barricades and signs. It is nearly always necessary to permit traffic to move during patching; therefore, the road or street is generally kept open for one-way traffic and sufficient passing space are provided so as to inconvenience the traveling public as little as possible. Barricades to protect the patches from traffic are usually wooden horses painted in contrasting colors so as to be discernible at considerable distances.

Warning signs are usually provided and lights or torches are placed at night to warn traffic. Stationing of a night watchman is also suggested to maintain the barricades and lights and keep them functioning at all times.

During the present emergency several states, because of lack of equipment and manpower, have grouped needed patching into projects and done the work under contract. According to officials of these states, such contracts have been practical and most successful in expediting the work, thus enabling them to maintain their highways in good condition during the war emergency.

Design of Airfield Pavements Developed by U. S. Engineer Department

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LIKE all expanding war activities, air power tends to transcend human limitations. Obviously runways designed for automobile use—the only comparable structures in engineering experience—were inadequate. In addition the wheel loads of military planes kept expanding out of all proportion. What expedients the War Department attempted in order to handle this design problem are here explained. Studies, records, comparisons, special track tests, and new procedures—all were undertaken. The record is one of combined vision and accomplishment, and the research program continues.

DEVELOPMENT of methods for designing airfield pavements by the U.S. Engineer partment has followed a course rted to parallel as closely as posle the changing trend of airplane ign. At the time the responsibil for the design and construction ilitary airfields was given to the ice of the Chief of Engineers, S. Army, in the latter part of vember 1940, the DC-3, now in mon use by commercial airlines, s considered of fair size. This lane has a total gross weight of roximately 25,000 lb, or 12,500 er wheel, and the average lands and take-offs from major airports were in the order ne hundred a day.

or military airfields, the design started with a wheel d of 15,000 lb and, as the program progressed, rerements increased—first to 37,000 lb and later to 000 lb, with a much greater wheel load in immediate spect. Also the traffic on Army Air Force training ds greatly exceeded that on commercial airports; to 800 operations of heavy bombers per day from one field were not uncommon, while those of light nes greatly exceeded this number. It became the of the Army engineers to provide surfaces for aircraft vel in keeping with this change of loading and at a e to keep ahead of production.

ADJUSTING FUNDAMENTAL PROCEDURES TO FIT

t must be remembered that the Department had to rt almost from scratch. Since there were no other a available, it had to adopt in the beginning, by essity, the principles of highway practice. It bee increasingly evident that these principles were not irely adequate for airfield design since even the initial lane wheel load of 15,000 lb greatly eeded the highway load, which was ely more than 9,000 lb.

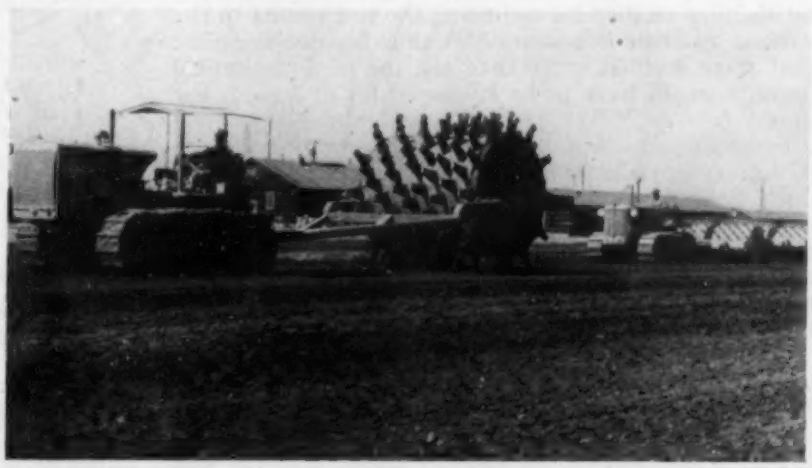
here was also a vast difference in the ctural and operational characteristics. e distribution of traffic was dissimilar, essitating a revision of thought on stress etition. The broad expanse of paved as, together with the intermediate unred areas of large extent, called for a ision of thought on the removal and disal of storm and subsurface water.

n the beginning the problem was that stablishing procedures for designing both ible and rigid-type pavements to withd the anticipated volume of traffic and stresses produced by existing and anpated heavy military and transport aires. It was considered necessary to blish design procedures to (1) insure quately designed pavements; (2) eliminate a wide variation in designs based on the judgment of paving engineers who were not fully acquainted with the requirements of the Department and with airplane traffic; (3) limit the use of unproved, theoretical design methods for flexible pavements; (4) provide in the Department a uniform design procedure not related to arbitrary cost differentials of local and competitive materials, and to avoid reductions of pavement thickness to balance costs; and (5) secure a basis for further development of design methods through tests, investigations, and study of the actual behavior of pavements.

Progress made since 1940 is the result of large-scale and broadly conceived experimentation, intensive investigation of the experience of the Department and others, and close liaison and coordination with the Army Air Forces. The investigations have included experimental tests to determine the effect of repetitions of loads on various types and thicknesses of pavements, and have led to the adoption of tentative design curves, correlated with the test data.

Investigations have been divided into three distinct phases: investigations of flexible pavements, those of rigid types of pavement, and general investigations applicable to either type. As rapidly as the results could be analyzed and correlated, they were published as appropriate parts of a chapter of the Engineering Manual, issued by the Office of the Chief of Engineers. As new data developed, the chapter was revised to bring it up to date.

A résumé of the investigations is here given. As reports of investigations are completed and approved, copies are sent to the Engineering Societies Library in



TEST OF EQUIPMENT FOR HIGH SOIL COMPACTION
Operating 30-Ton Sheepsfoot Roller

SETUP FOR "IN-PLACE" TEST, ACCORDING TO CALIFORNIA BEARING RATIO (C.B.R.) PROCEDURE

New York in order that the information may be made available to those interested.

FLEXIBLE PAVEMENTS INTENSIVELY STUDIED

At first all the available procedures developed for highway design were studied. Although such methods have considerable merit, they were not adopted since it was believed that proper procedures for determining the "bearing capacity" of the subgrade had not been fully developed. In an attempt to make use of various formulas, the Department conducted special field investigations at Langley and Bradley airfields and on a Virginia Highway Department test section to develop procedures for determining subgrade bearing values applicable for use in various theoretical formulas.

These brought conclusions that (1) development of a satisfactory test procedure would require extensive investigations which could not be accomplished in time for use in the war emergency program; (2) in the field plate-bearing test, the proper deflection to determine the "bearing capacity" depends upon the basic assumptions in the formula and varies according to combinations of many factors; and (3) in most cases, results of the plate-bearing test would not be applicable to the soil moisture conditions expected ultimately to develop below a pavement, and it would be extremely difficult to develop a satisfactory method for adjusting the test results to the various moisture conditions. It thus became apparent that some method other than the use of a theoretical formula would have to be employed for at least a few years.

Several engineers proposed using plate bearing tests on pavement surfaces for the design of flexible pavements. Such field tests were made on pavements and base courses, and led to the conclusion that the same factors that must be considered in using this test on subgrade soils must also be considered for pavements. In addition, the compressibility of the pavement and that of the base material entered into the problem.

Early in 1942, after several months of intensive study and investigation, the principles used by the California Highway Department in designing flexible pavements were tentatively adopted. These consist of determining a modulus of the shearing strength of the subgrade soil by test and using this modulus with empirical curves developed by studies of pavement service to determine the required combined thickness of base and pa-ment.

The principles were tentatively adopted beca (1) they were considered to be as sound and logical any others; (2) they had been used successfully by California State Highway Department to develop method of design applicable to flexible pavements; North Dakota and Florida had used similar principles some extent for the design of highway pavements; (4 satisfactory method could be developed more quickly based on these principles than on any others; (5) accel ated traffic tests on existing pavements and on spe test sections could be made with large wheel loads, the results combined with the data of the empiric design curves of the method developed by the Califor Highway Department, to quickly develop design cur for airfield pavements for any required traffic; (6) C.B.R. (California Bearing Ratio) test developed by California Highway Department to determine modulus of stability of the soil, for use in the Califor method of design, could be adopted for immediate u (7) all soil tests could be made in the laboratory w simple equipment; and (8) the soil test could be made saturated samples representing the conditions th develop beneath most pavements, or at other moistu contents.

It was believed that the C.B.R. test procedure wo be satisfactory for testing all types of soils provided field compaction standards for airport pavements we the same as those used by the California Highway De partment.

SPECIAL TRAFFIC TESTS ADOPTED

Accelerated traffic tests were made on existing airfie pavements at Corpus Christi, Tex.; Dothan, Al Fargo, N.Dak.; and Lewistown, Mont. These te were performed until destruction of the pavements o curred, using wheel loads ranging from 15,000 to 50,0 lb. In order to obtain more detailed information, specially constructed test section was built at Stockt

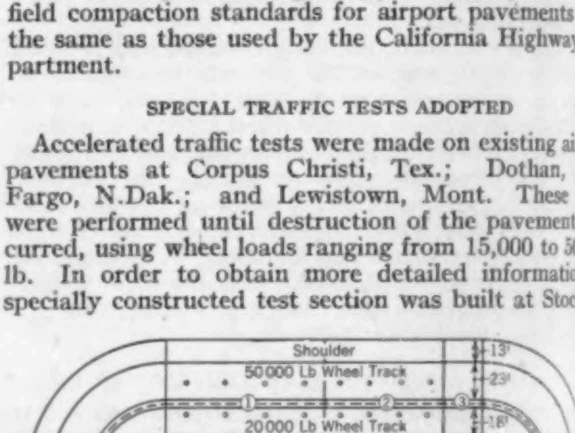


FIG. 1. LAYOUT FOR ACCELERATED TRAFFIC TESTS, BARKSDALE FIELD

Army Airfield, Stockton, Calif. This section was su jected to wheel loads ranging from 25,000 to 54,000 produced by airplanes and earth-moving equipment.

Tentative curves applicable to airfield pavement de sign were prepared by consultants and personnel of th Office, Chief of Engineers, on the basis of these data

To refine the design curves, additional data were ob tained by accelerated traffic tests on existing paveme as well as on specially constructed test sections at number of airfields. Those at Barksdale Army Airfi

duced so much valuable information at a brief description appears worth while. e accelerated traffic tests were made in 12 and 1943. The special test section s composed of two concentric tracks nstructed in an oval shape on a clay bgrade (Fig. 1), one subjected to the ffic of a 50,000-lb wheel load, and the her to a 20,000-lb wheel load. Each ck was divided into eight items of differ- t designs. Items 3, 4, 6 and 8 were un- faced and formed the transition panels d turn-arounds. All others were 100 ft length and paved with 3 in. of good- ality asphalt concrete.

The base for Item 1 consisted of vari- s layers of materials designed according the California method, with total thick- s over the subgrade varying from 25 45 in. and from 13 to 30 in. for the 000 and 20,000-lb loads, respectively. m 2 was the same, except that a poorer ality of base material was placed directly beneath the phaltic concrete surface. Similarly, for Item 5, the se was composed entirely of high-quality material. The e of Item 7 was composed of soil cement, and the al thickness of base and pavement varied from 13 to in. in both test tracks.

Traffic on both tracks was continued for 5,000 cover- s. Deflections of subgrade and pavement surface, d vertical pressures in the subgrade, were measured oughout the tests by means of electrical devices. flections were measured for moving and static wheel ds and rigid-plate bearing tests (repetitions varying m 1 to 58) were made on the pavement and sub- de in accordance with a procedure recommended by Asphalt Institute. Complete tests on soil, asphaltic crete, and soil cement were made. The results of this estigation are included in a report entitled, "Service havior Test Section, Barksdale Field, Louisiana," blished by the Little Rock District, Corps of Engi- rs.

ASPHALTIC CONCRETE SURFACE BEING CONSTRUCTED SPECIALLY FOR TESTING AT EGLIN FIELD

SOME MODIFICATIONS IN ORDER

It is believed that no more special test sections are uired for wheel loads of less than 60,000 lb. Studies airfield pavements under service will yield the desired ther information. However, a special flexible pave- nt section, to be tested with a wheel load of 150,000 lb, being constructed to furnish data for design curves ond present limits.

The C.B.R. test previously referred to is essentially a etration (shear) test to determine a modulus of bility of soils. It is made on undisturbed soil taken m beneath the pavement to determine the carrying acity. At the time the principles of the California thod of design were adopted for flexible pavements the Corps of Engineers, it was believed that the thod of preparing the sample and the C.B.R. pene- tion test procedure, could be used in designing flexible port pavements, provided that the compaction actu- y achieved during construction produced densities ivalent to those obtained by the construction and trol methods used in California.

Soon after adoption of the C.B.R. test, it became evi- t that the compaction method used in preparing the nple for design test would have to be revised in order utilize available equipment and to obtain the densi- s required by the specifications. The method of com- tion adopted was similar to that for field compaction control tests (modified test of the American Association of State Highway Officials). Because of some inconsistencies in test results, and the need for modification in preparing the remolded samples for the design test, a program of investigations was conducted by the Department's Flexible Pavement Laboratory, at the U.S. Waterways Experiment Station, Vicksburg, Miss.

Although these investigations related to the California method of design, considerable information was obtained which is useful in developing any method. During the field tests on special pavement sections, deflections and pressures were measured for various conditions of loading. Several kinds of tests, including plate bearing, triaxial, and consolidation tests, were made. A special testing device was developed at the Massachusetts Institute of Technology for determining the effect of deflection on the stress distribution below a base course.

In addition, it was necessary to establish criteria for the thickness and quality of the bituminous surface required, and for the quality of the underlying base material. Tentative criteria were adopted pending the securing of additional information. A suitable apparatus has been developed for determining the stability and control of bituminous mixtures, designated the Marshall stability method. Further results may be expected from investigations in the Mobile and Tulsa Districts and at the Flexible Pavement Laboratory.

To formulate a design procedure for concrete pavements, existing data were studied and special investiga-

ACCELERATED TRAFFIC TEST ON EXISTING RUNWAY AT FARGO, N. DAK., AIRPORT

DEFLECTION TEST ON PAVEMENT BUILT FOR THE PURPOSE, AT MARIETTA, GA.

tions were made at Langley, Wright, Godman, and Camp Forrest airfields. It was concluded that (1) the plate bearing test, using a plate 30 in. in diameter, should be used to determine the foundation modulus; (2) the third-point loading method, as recommended by the A.S.T.M., should be used to determine the concrete-strength modulus; (3) insufficient data were available to form empirical design curves showing the relation of load, thickness, soil modulus, and concrete modulus; (4) the Westergaard formula was the best for determining the relation between load, thickness, and soil modulus, and the relation between load and thickness was approximately valid for a clay subgrade; and (5) the composite effect of such factors as warping, compaction of subgrade at corners, load transfers, repetitions of loads, and internal concrete stresses, for normal conditions should be assumed constant and considered in the design by reducing the working stress of the concrete.

Following formulation of the design procedure and publication in the Engineering Manual, data from previous investigations have been further analyzed. Other investigations have been made on a specially constructed concrete pavement at Lockbourne Army Air Base, Columbus, Ohio. The test track constructed in the fall of 1943 consists of two parallel pavements 490 ft long and 40 ft wide, made continuous at each end by 8 segments to form a 180° turn. The straight track is divided into 18 panels, 40 ft square, of various designs, varying in thickness from 6 to 10 in., and placed on the natural clay subgrade, as well as on various types and thicknesses of base courses. Some panels are reinforced with wire mesh and others consist of one concrete slab over another. Panels are separated by 10-ft transition sections. Various types of transverse and longitudinal joints and non-commercial joint transfer devices are incorporated in the end segment sections.

Traffic testing was started in April 1944, using a 37,000-lb wheel load on the inner half of the track. The 6-in. pavement slabs on the outer half were tested with a wheel load of 20,000 lb, and then with one of 60,000 lb. Prior to starting the 60,000-lb traffic and before completing the 37,000-lb test, new test panels were constructed in failed areas. Some of the new panels are reinforced with structural steel.

Both before and during the traffic testing, slab deflections were determined by electrical devices. Adjoining each traffic-test panel, one of similar design was constructed for static load tests.

Extensive surveys of pavement condition are planned at numerous airfields to obtain additional information. A special pavement constructed at Lockbourne Airfield will be subject to traffic of a 150,000-lb wheel load. Still another special investigation will probe the value of using overlay pavement to strengthen weak or failed concrete slabs not serviceable for anticipated heavy traffic. Such investigations are under way.

Little information is available as to the base-course requirements to compensate for the effects of frost action on pavements for heavy planes. The criteria in the Engineering Manual are the result of opinions of authorities with highway experience. To obtain specific data, the carrying capacity of existing concrete and flexible pavements during the frost-melting period of 1943 was determined at Dow Airfield. An extensive frost investigational program began in the fall of 1944 and will continue to the summer of 1945.

Throughout all the programs, general investigations pertinent to the design of rigid and flexible pavements have been made. Investigations are being organized to determine the degree of saturation of soils below pavements and the changes with time, and to determine best compaction methods and type of equipment to obtain the high soil compaction necessary. Carrying capacities of pavements at all Army Air Force fields have been evaluated in accordance with the design principles in the Engineering Manual. (Since the evaluation surveys were made at military airfields, the information has not been given general distribution. These surveys will be the subject of a second paper in a subsequent issue of CIVIL ENGINEERING.)

ASSIGNMENTS TO VARIOUS LABORATORIES

Several laboratories in the Department have been designated for this work, and their scope enlarged to permit delegation of specific functions to them. The Flexible Pavement Laboratory, at Vicksburg, Miss., coordinates tests and investigations relating to bituminous pavements and their foundations. The Rigid Pavement Laboratory at Mariemont, near Cincinnati, Ohio, coordinates tests and investigations dealing with concrete pavements and their foundations. The Frost Effects Laboratory, at Boston, Mass., in the same way coordinates tests and investigations on the behavior of subgrades and base courses subjected to frost action.

The work of these laboratories, as well as other related activities, is outlined and coordinated by the Office of the Chief of Engineers. The resources brought to bear on airfield design problems by these means are believed to be adequate to keep abreast of aeronautical developments. The wealth of information gained, together with the organization established to continue the investigations, should have an important bearing on the airfield design of tomorrow.

Basic Magnesium—the Desert Giant

III. Progress and Auxiliary Services

By J. R. Charles, M. Am. Soc. C.E.

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In such a vast project as Basic Magnesium, there are innumerable details of engineering interest. Its magnitude, complicated by the pioneering nature of the installations, and the extraordinarily fast schedule imposed, made it a most unusual project from the technical viewpoint. This last paper of the series tells of some of the special problems, why they arose, and how they were solved. Previous articles, in the January and February issues, have covered the general aspects of the work and the contractor's methods.

Having gained an overall view of the tremendous work on Basic Magnesium d of the general construction nning, as given in preceding tallments, the reader may well nder how the varied details were ndled and integrated. Space ll permit only a brief mention of a v salient features having special peal to civil engineers.

Water supply was pumped from ke Mead, some 14 miles away, er a range of mountains to the nt reservoirs on high ground at e south end of the site. At the lake, a cantilever idge containing 1,000 tons of steel was built to project 3 ft out over the water. At the end of this bridge six ep water pumps were hung, with the motors on the idge and the pumps some 200 ft below (the rise and ll of the lake may amount to as much as 60 ft). The mps, which are capable of lifting up to 30,000,000 gal r day, discharge to a reservoir a mile or two inland, m which booster pumps, automatically operated and ntrolled, deliver the water through two 40-in. lines, er the mountains direct to the plant reservoirs. General plant supply is piped from the reservoir through a g main and alternate switch pipes, since the manufacring process is absolutely dependent upon a continuous pply of water. A quantity is bled off from the reserirs to a water treatment plant for softening, to render e hard lake water suitable for domestic and boiler es.

There are four separate water supply systems in the nt:

1. Boiler-soft water system, piped from the water atment plant direct to the caustic evaporation-plant iler installation and to subsidiary connections.
2. Recirculated water system, conveying cooled ter in the ring-main, pumped back from the cooling wers.
3. Domestic system, furnishing treated and controlled ter to all domestic points throughout the plant.
4. Fire-protection ring mains, a very necessary stem, doubly important in this arid country, where nber becomes so dry and hot that it represents a conerable fire hazard.

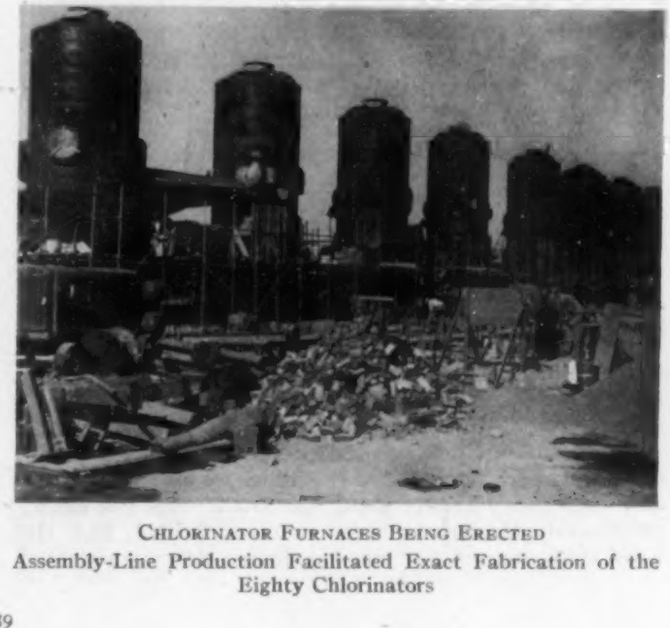
Plant effluent, containing solids in suspension and ces of acid, up to 15,000,000 gal per day, is collected vitrified pipe systems and conveyed by gravity to the v end of the site—at the north. Effluent is neutralized limestone and waste caustic liquor from the chlorine nt, and then flows in wooden launders to a series of tling and evaporation ponds almost half a mile square. ese large ponds are expected to deal with all plant de waste—in part by ground penetration, but largely solar evaporation.

There are five separate drainage systems:

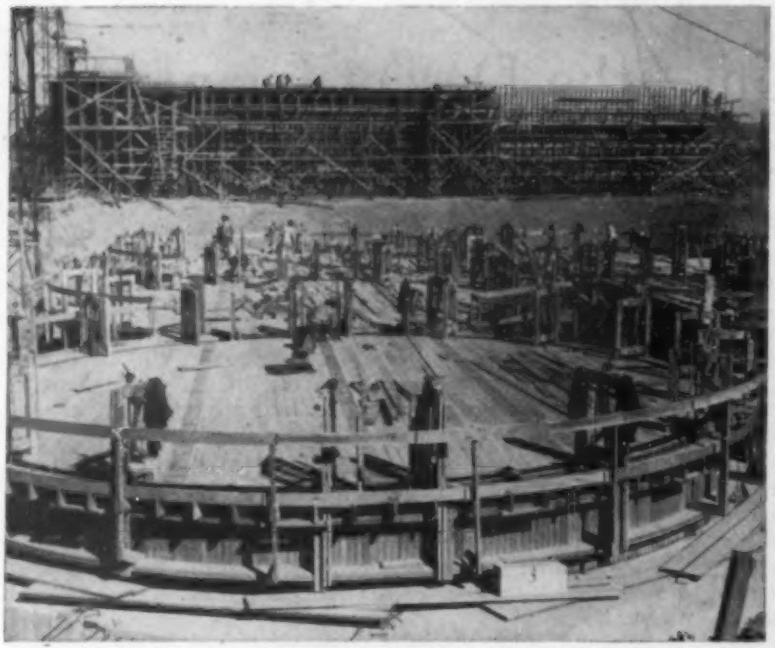
1. Absorber tower drains take the waste effluent m the caustic tower, which treats the final waste ses from the chlorinators before they are emitted to the atmosphere, thus ensuring that no injurious or obnoxious gases are put into the air around the plant. This system conveys the liquor to the north, through the effluent neutralizing plant and joins into the evaporation ponds.
2. Acid drains collect, in stoneware pipes, all the acid-contaminated cooling and waste water and deliver it to the effluent neutralizing station, thence to the settling ponds.
3. Sanitary drains collect all sewage and domestic drainage from the whole plant and town site and deliver it to a sewage treatment station to the northeast, on the far side of the highway.
4. Recirculation drainage collects all non-acid waste water and delivers it to large timber cooling towers, for cooling and collection at their bases before it is pumped back into the plant mains for re-use.
5. Storm drains, of large section, collect storm water from the whole plant and lead out to the north. Although rain is infrequent in this country, when it does come the quantities are enormous and any flooding of plant roads, drains, cellars, and metal units is extremely dangerous and likely to put the plant out of action. Ample provision must be made for emergency storms.

SHOPS AID CONSTRUCTION

Mechanical and electrical workshops consisting of two main bays, each with side shop annexes, were constructed entirely of concrete and provided with overhead electric cranes. They take care of all mechanical repairs, welding and boiler jobs. They have no windows and are completely air conditioned. Located as the plant is, 350 miles from contracting engineers' shops in Los Angeles, it is essential that the repair shops be com-



Chlorinator Furnaces Being Erected
Assembly-Line Production Facilitated Exact Fabrication of the Eighty Chlorinators



SLIP FORMS FOR MAGNESITE SILOS

pletely equipped for all maintenance likely to arise. Sections of the shops are fitted up to deal with copper bus-bar fabrication and reconditioning, preparation of anodes and cathodes, and sundry electrolytic cell parts.

Electric workshops can deal with all motors, switchgear, and transformer overhaul and repairs. Painting, carpentering, and lifting-tackle shops are complete to take care of any job that may arise at the plant.

One of the most meticulous jobs on the whole plant was the preparation of the acid-resisting and heat-resisting brickwork with which the cells and chlorinators are lined. A whole series of shops were devoted to this exacting work of shape sorting, grinding, fitting, and machining for erection. A carefully devised system of flow, tied in with repair programs based upon "lives" of plant units, enabled stocks and preparation of shapes to be scheduled steadily ahead of plant needs. Some very ingenious machinery was used in the grinding of large blocks and shaping of refractory tubes up to 16 in. in internal diameter. In addition, special refractory castings, refinery furnaces, and rotary kiln refractory work was handled from this section. This is a very important and costly department of the plant and warrants first-class ceramic guidance and continual research into improved materials and better methods and techniques of preparing and setting the refractories.

INGENIOUS METHODS ADOPTED

Each of the 80 chlorinators consisted of a circular vertical furnace casing of steel, 30 ft high by about 10 ft in diameter. This casing was lined with many layers of acid-resisting and heat-resisting refractory. It was essential, on account of the extremely accurate fitting of the brickwork, that these vessels be fabricated to fine limits and not distorted before erection on their foundations. So it was decided to ship all the material in the form of plates, rolled to radius, and in this form it was received at the site.

An assembly track was erected in the field, the plates of each furnace being tacked together by electric welding and then rolled slowly along the track. As the casing progressed, the seams were machine-welded, and the large steel castings for tapping doors, etc., were welded on. At the end of the line the finished furna[ce] was subjected to air pressure and a soap te[st] and then as a completed unit was lifted [by] heavy portable cranes and moved straight on[to] its foundation in the proper metal unit. As [a] result of this extremely ingenious method [of] fabrication, the degree of distortion was [so] minute that in very few instances was adjust-ment needed after erection.

The 880 electrolytic cells were delivered [as] large rectangular tanks, prefabricated to si[ze]. All these cells were to be mounted on a numb[er] of small I-beams, in turn carried on the insulat[ed] steelwork of the cell room. These tanks we[re] up-ended, placed across a wooden jig, and th[e] supporting beams welded to the bottom in su[ch] a way that all welding was downhill, and th[e] risk of bottom distortion was avoided. O[n] completion at the jig, the cell tank was lifte[d], reversed to its correct position, and droppe[d] straight into place under the cell steelwor[k]. This method overcame a great many erectio[n] difficulties, usually caused by distortion duri[ng] welding, as well as the problem of lining up [a] multitude of supporting beams.

During the months that the special refra[c]tory shapes were being made, the contractor w[as] busy recruiting a team of the very best retort sette[rs] available (it was estimated that about 1,000 masons wou[ld] be needed). Meanwhile he had a complete cell made i[n] timber and a set of refractory shapes made in plaster o[f] paris. His refractory superintendent lectured and traine[d] his foremen and key bricklayers using this extreme[ly] novel and practical method. By this means a good num-ber of masons were already familiar with the job by th[e] time the first supplies were in, and wasted no time in ge[t]ting in practice.

The busbars, 3,000 tons of which were copper a[nd] 1,000 tons silver (the latter purely a war measure as th[e] silver will go back eventually to the Treasury va[ults] from which it was loaned), were of a section 8 by 1/2 i[n.] This is a very large bus-bar section and extremely di[f]ficult to handle. However, all bus bars were delivere[d] to the job, cut to length and flat. Batteries of multip[le] drilling machines were set up, with gravity conveyo[rs] and bus bars were passed through drill templates a[nd]

MECHANICAL GRINDING FOR REFRACTORY BRICK ENSURED EXACT SIZE

nt to shape in hydraulic bending maines. The finished bars were then ganged gether, bolted, and placed in sections so ranged that the copper work for each dividual cell could be delivered complete d hauled by crane direct to position, thus oiding much bolting and lining up in the ection bay.

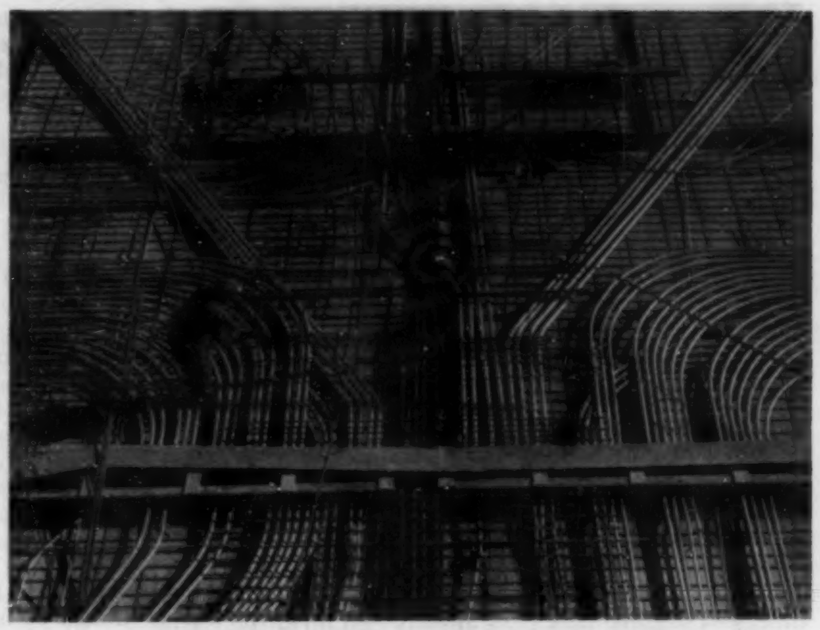
Houses at the town site, 1,000 in number, re all constructed by the main contracr and were of prefabricated construction. ousing installations, that is plumbing, oler ducting, wiring, fittings, and so forth, re assembled in units in the plant workops. The whole was so well organized at every section and unit fell into place actly to schedule, permitting the avere rate of completion to reach 5 houses per y. The housing project makes a comete and extremely interesting story in elf, as it was a monument of organizaon in the building of such projects.

Grading for the general plant, the bulk the excavation, and the construction of e disposal effluent ponds were carried out a large quantity of heavy grading and raping equipment, the operation of which s again closely and accurately organized by the main ntractors so that it flowed steadily forward without y confusion. The average site level being approxiately at grade in the center of the plant, the excavating s worked from two directions and the spoil was trucked

INTERIOR LAYOUT OF CELL ROOM

t to the north in such a way as to change the comparaely steep natural slope to that required for the dif ent plant levels. This was skillfully done and no out e fill was needed.

The magnesite silos, constructed entirely in concrete, re continuously cast, using metal forms. There was no p in pouring from the foundation to the top. Conte reinforcement was analyzed, scheduled, and bent the site, then delivered to its destination in semiefabricated sections, thus avoiding a great deal of justment of steel within the forms.



READY FOR CONCRETING FLOW-OF-METALS BUILDING
Conduits and Reinforcing Steel in Place

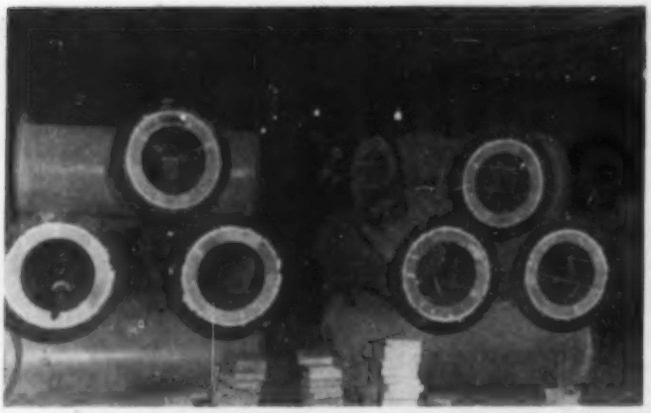
A progress control room set up by the main contractors proved most useful. Along the whole of one wall was mounted a huge plant layout plan. By a system of colors, the section progress was continually planned ahead and material routing was controlled to avoid bottlenecks. Sectional construction charts, read in conjunction with the plan, indicated the targets for each part and the actual position to date. Constant inspection by field superintendents made any holdup or lag immediately evident. Thus no delays could accumulate. In addition, all purchase orders and subcontractors' positions were charted with up-to-date progress reports, so that the field engineers always had up-to-the-minute information on which to plan their work. This control, very cleverly devised and operated, tended to keep the whole construction running very smoothly and played a very large part in bringing the units of the plant to completion at the scheduled dates.

By June 27, 1942, a fair start had been made with the concentration plant. At that time some teething troubles were experienced, but even so a reasonable supply of MgO reached the reduction plant in time for the scheduled start.

On August 3, the first circuit of the chlorine plant took its load without a murmur, and almost immediately good quality chlorine was produced, though the caustic liquor had to be run to waste because the recovery unit, not yet scheduled for completion, was unable to accept this effluent, regarded as a by-product. The salt, furnishing the material for this first output, came from the surface of Death Valley. The chlorine was emptied and loaded into the first 50-ton rail tank cars ever used for this gas and was shipped away regularly for use in other war plants.

Soon the first electric furnace (chlorinator) was ready for drying out—an extensive and exacting operation consuming large quantities of scrap timber. By August 20 this furnace was ready for electric load and its first charge.

Meantime a start had been made in the preparation plant, and briquettes of suitable quality were made within a day or two after rolling started. As previously explained (in Part I, January 1945), recovered hydro-



TYPICAL PIPE SHAPES WITH BRICK LINING

chloric acid and MgO were needed to form $MgCl_2$ for the briquette binder; but of course at that date there was no HCl to recover. Thus it was necessary to get either a small quantity of HCl or $MgCl_2$ in order to start the circuit. The former was very difficult to obtain at that time, and suitable tank cars, already tied up in the East, could not be spared. Therefore the more easily obtainable $MgCl_2 \cdot 6H_2O$ crystals were purchased in bags so that the preparation plant could start. Once started, of course, it became self-sustaining.

When the electric furnace had been flushed out with salts and fluxes, the first charge of briquettes was loaded in on August 24. Three days later the first $MgCl_2$ anhydrous was successfully tapped into the waiting crucible car. Meantime, six electrolytic cells had been heated up to working temperature, with crews trained in switching on the cells. The great morning of August 30 dawned with a perfect tapping of $MgCl_2$, transfer to the cells, switching over to d-c current, valve changing to apply the chlorine and cathode gas suction to the cells, and without hitch the d-c load was brought up to working strength. The most difficult and tricky part of the whole operation thus successfully accomplished, magnesium metal was being made. By 11.0 p.m. on the night of the 31st, just 24 hours behind schedule, the first Nevada magnesium was floating happily on the electrolytic surface and was recovered and cast into blocks. Thus metal was being made exactly according to the predicted time cycle. Visible, sound, raw products were available one day later.

The whole of the month of August was a most hectic time for the operators and constructors. Each was trying his utmost to keep up to schedule—to get in, do his job, and get out of the way of others, and so help to bring the long task to fruition. The key men, from top to bottom, just plugged away non-stop, without letup or sleep for the last six days and nights, existing on little but black coffee and sandwiches.

ON TO FULL PRODUCTION

It will be recalled that the plant consists of 10 standardized metal units, each self-contained and independent. The reason for this size is too involved for detailed discussion here but it was undoubtedly considered at the time of planning (1941) to be the latest and best layout according to the knowledge then available. In order to meet the output date, units were scheduled to be completed in sequence, and production was obtained while construction on later units was still in progress. The time taken to get the first unit ready was a record, only once previously approached on a plant of smaller units under peacetime conditions. Because of limiting factors, the most optimistic estimate was that one u could be brought to full load per month. Allowing f inevitable difficulties, it was considered that 12 month would be required to bring the whole plant to full production.

It is a great tribute to the operators, all of whom had learn the job as they went along, that the last u reached full production exactly 11 months after the fi unit turned out the first piece of metal. Thus an avera of one unit per month was maintained through the wh period, and the output curve, straying a little at time particularly at the beginning when everybody and every thing was green, nevertheless maintained a straight-li tendency and made a bullseye on its target a mont ahead of the expected date. Such an achievement, ev on small plants, had never been reached before, a again another record was smashed with an all-time hi on speed of construction and operation.

This is not all, however—the plant steadily reache and then passed the rated output and has now for a lo time produced practically 10% more than its design capacity. This is somewhat unusual for a metallurgic plant, the factors of which are so exasperatingly co trolled by nature as to give little margin on calculatio Again this is a great tribute to the fine quality of th workmanship and the soundness of the design built in the job. If it had not been fundamentally right, su performance could not be maintained; bottlenecks, erro in basis, poor materials, and breakdowns would ve quickly have taken care of that.

A few data on the overall quantities involved w tend to summarize the magnitude of the problem Structural steel amounted to 50,000 tons, requirin 300,000 rivets and 200,000 bolts. Concrete totale 182,000 cu yd; lumber, 30,000,000 fbm; paint, 250,0 gal; and excavation 6,000,000 cu yd. Plans required 4,0 drawings, enough to cover 30 acres. The finished pla uses daily 1,400 tons of raw material, and 15,000,0 gal of water; the total power load is 200,000 kw. In cluding mine operation at Gabbs, the town site, powe water installations, and manufacturing, the cost totale about $140,000,000. Fuller details of the conception an prosecution of the work are to be filed in the Engineerin Societies Library in New York.

For the Defense Plant Corporation, W. L. Drage M. Am. Soc. C.E., was chief engineer. Magnesium Elek tron, Ltd., was responsible for all technical design training of operators, and starting of the process, unde Maj. C. J. P. Ball, President; J. R. Charles, M. Am Soc. C.E., chief engineer; Dr. S. J. Fletcher, chief chem ist; W. Mawdsley, civil engineer, and others. Fo Basic Magnesium, Inc., Col. W. F. Way, M. Am. So C.E., was construction manager.

Contractors for the water supply system from Lak Mead to the plant, including the reservoir and wate treating plant, were Engineers, Ltd. Contractors for th high-tension high-transmission lines from Boulder Da to the terminal sub-transformer station at the plant we Fritz Ziebarth, Inc.

Consultants to the Defense Plant Corporation we Coverdale and Colpitts, for whom George W. Burpee, M Am. Soc. C.E., was director of all engineering at the plan Engineers for the water supply system from Lake Mea to the plant were J. M. Montgomery and Company o Los Angeles, represented by Harold Barker, M. Am. So C.E.

The main contractors, McNeill Construction Compan were represented at first by Wilmot E. Whittier, chi engineer, later by Sherman Mason, author of the seco paper of this series.

Engineers' Odyssey to Europe—1889

III. Lavish Entertainment in London

As Remembered by Four Remaining Society Members Who Were Present

By A. Prescott Folwell, James B. French, Andrew J. Provost, Jr., *and* T. Kennard Thomson, Members Am. Soc. C.E.

Fresh from a week of sight-seeing in England and Wales, the large party of American engineers and their ladies converged on London in the middle of June 1889. There followed an endless round of social activities in and about that city. Technical meetings were not permitted to intrude. But trips, receptions, dinners, and luncheons crowded the days. This grateful account of a full week of English hospitality at its best carries the story up to the embarkation for France and its Centennial Exposition.

French: The time of the American Engineers in London, from their arrival late dnesday, June 12, to their deture for Paris on Thursday, June was filled with a continuous sucsion of events carefully planned their information and entertaint.

Provost: On the morning of ursday began the eight-day cycle social, educational, and fraternal ertainments. Their variety, pe, and generosity, while tending bewilder us at times, were destined to give us a ling of life-long gratitude to Mr. James Forrest, inatigable Secretary of the Institution of Civil Engirs, and his staff, who so generously contributed the luous labor and forethought necessary to organize and ctively carry out so extensive and interesting a prom for our entertainment. He even arranged privies for us in a number of London clubs.

Thomson: It was interesting to note how, with the nost politeness, he guided the President of the Instie at the meetings and dinners. Naturally the permat secretary knew more about running the organization n the short-term president.

French: In all probability he was more directly rensible for the detailed planning and execution of this ndon program than any other person present. At y rate, in the opinion of many of us Americans, nothing tributed more to the effective movement of the large ups on the various trips, where rigid time schedules d to be insisted on, than the tact and courteous dimacy of Secretary Forrest. I am sure all of us surors remember him as one of the finest men we met on s European trip.

Provost: In the afternoon, we were received at the ne of the Institution of Civil Engineers, in Great orge Street, Westminster, S.W., and welcomed by Sir n Coode, the president. His address was finely illumied for preservation, and a framed copy was sent he Society (see November 1942 Civil Engineering, e of Special Interest).

n the evening a dinner was given by the Institution of il Engineers at the historic Guildhall of London. This s said to be the first use of the hall, other than by the y of London itself, for the expression of civic hospital- There were 450 persons present.

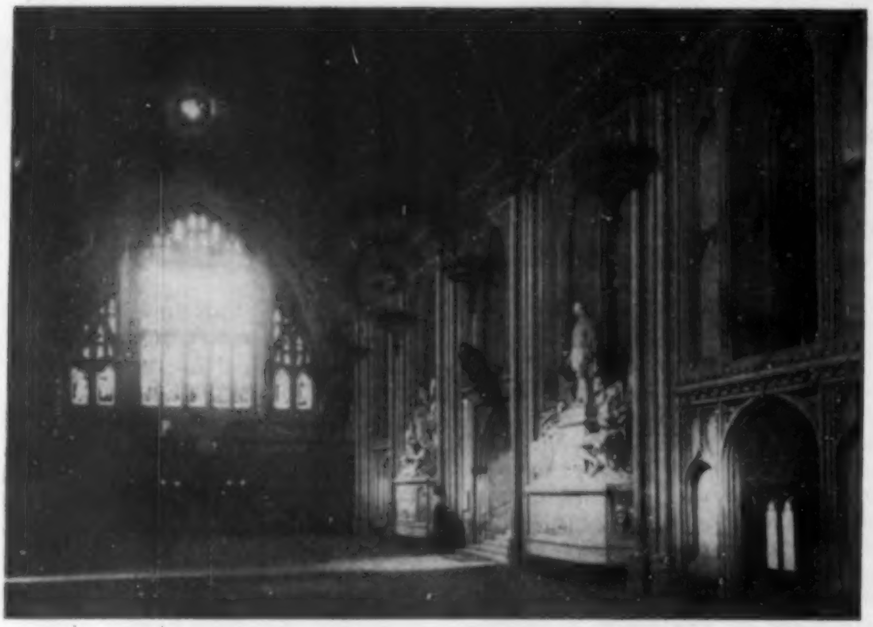
French: The Guildhall Dinner was of course the outnding event of the whole London program. It had n planned so carefully in advance that when the sts had deposited their coats and hats in the cloak m, they were given large printed sheets on which was a gram of all the tables. On this were printed the name ach guest at the table and the seat to which he had n assigned, together with an alphabetical index giving names of all the guests, by which each could definitely ate himself. Care had been taken to have each American flanked by an Englishman on each side. When a guest reached his seat he found a menu card with his name printed on it, and from the diagram he could get the name of the Englishman on each side of him. This seating diagram contained the names of over 400 guests.

Among those at the head table can be named, as prominent Englishmen, Sir John Coode, President of the Institution of Civil Engineers, who presided; Sir John Fowler, principally responsible for the construction of the Forth Bridge, whose partner Benjamin Baker (not yet knighted) sat at an adjacent table; Sir Henry Bessemer, responsible for the Bessemer process of steel making; the Dean of Westminster; the venerable Archdeacon Farrar; the Sheriff of London; and as prominent Americans: Robert T. Lincoln, "The United States' Minister"; Henry White, of the American Legation; D. J. Whittemore, Past-President, Am. Soc. C.E.; H. R. Towne, President, A.S.M.E.; A. E. Hunt, Vice-President, A.I.M.E.; T. C. Clarke, Later President, Am. Soc. C.E.; C. E. Emery, Secretary, Visiting Engineers; Octave Chanute, later President, Am. Soc. C.E.; W. H. Wiley, Treasurer, A.S.M.E.; Prof. Robert Thurston; Prof. Elihu Thomson. Inconspicuously at one end of this head table appeared the name of "Mr. Forrest," the sole identification of Mr. James Forrest, Secretary of the Institution of Civil Engineers.

Provost: Thereafter, it usually was necessary to divide our large party into two or more groups. The programs were varied and so extensive that no one person could have taken part in all of them.

At Barking, below London, where the purpose of the sanitary work was to reduce the pollution of the lower Thames, the sewage wastes of the city were held in large basins and treated with chemical precipitants. The resulting sludge was pumped into barges and dumped at sea some forty miles off shore. At the time of our visit

Home of the "Mother of Parliaments," Beside the Thames
Big Ben in Tower at Right



INTERIOR OF GUILD HALL, SCENE OF ELABORATE DINNER
"By the Express Sanction of the Right Honorable The Lord Mayor, Aldermen and Commons of the City of London in Common Council Assembled"

Dibdin was already experimenting with more complete treatment of sewage by holding it in short contact with beds of coke breeze. These experiments were soon demonstrated by the construction of a contact bed of this type at Barking. This bed, one acre in size, could treat one million gallons a day, and was the forerunner of the biological treatment processes that have since been so satisfactorily applied throughout the world.

At Lambeth Palace, the group listened to an address of welcome from the Archbishop of Canterbury, who then personally conducted the party through the palace.

At the Isle of Dogs, some of the group enjoyed the privilege of taking short trips on torpedo boats which traveled, it was said, at the extraordinary speed of twenty-five miles an hour.

FRENCH: On Monday our arrival at St. James Palace was timed to enable us to witness the Changing of the Guards, always attended by music from a fine band. Some of us felt that the old walls must have been shocked by the strains of "Yankee Doodle" and "Hail Columbia," played in honor of the visiting Americans. We were taken through the corridors filled with ancient armor, the picture galleries and reception rooms, and the royal apartments, including the throne room, which are seldom thrown open to visitors.

At Buckingham Palace, the Queen's residence while in London, we were also taken through the galleries and private apartments and shown every possible courtesy. But my interest as a young man raised on a farm was most aroused by the visit to the Royal Mews, the English name for the palace stable. Here, among other fine Arabian horses, we saw the 14 "creams" reserved to draw the royal carriage on state occasions. It is a pleasure to note that I had not then, and have never since, seen finer horses more scrupulously groomed.

PROVOST: On Saturday, by special permission of the Queen, then at the Isle of Wight, the entire party visited Windsor Castle. A special train of fourteen cars was provided for the trip of some fifteen miles. At the palace we saw many interesting things, among them a portrait of the Queen when she ascended the throne at the age of eighteen. We were conducted through apartments rarely shown to visitors, including those of the Queen, a most unusual privilege. After luncheon, which was served in Windsor Town, with the Mayor in attendance, carriages were provided for drives through the Great Park, the Long Walk, and thence to Virginia Water, where a profusion of rhododendrons were then at the height of their bloom.

FRENCH: The "Garden Party at Holly Lodge, Highgate, by invitation of Baroness Burdett-Coutts and Mr. Burdett-Coutts MP" from 4 to 7 p.m. Monday, June 17, was without doubt one of the most enjoyable features of our whole stay in London. The extensive and beautifully landscaped estate on high ground overlooking London was decorated everywhere with English and American flags; the afternoon was favored by bright sunshine which brought out the bright colors of the ladies' dresses. Music was furnished by the renowned band of the Coldstream Guards, and the hospitality and gracious welcome of the hosts were shown in every detail of the arrangements. Among the distinguished guests were the Marquis of Lorne; the American Minister, Mr. Robert T. Lincoln, and Mrs. Lincoln; the Chinese Minister and members of his suite, "resplendent in silk of many colors"; the Archbishop of Cyprus "in black canonicals and silver cross"; and our own Andrew Carnegie—not to mention the distinguished members of the English and American engineering societies.

PROVOST: One evening Lord Brassey gave a reception at his beautiful city residence in Park Lane. Music was furnished by Spanish performers in costume. Following the collation, the extensive museum of curios collected by Lord and the late Lady Brassey, on their trip around the world in the yacht *Sunbeam*, was inspected.

FOLWELL: My chief recollection of that reception was an aquarium similar to, but much smaller than, that later built in New York's Battery Park. This was in a fair sized room with walls all of glass, behind which swam fish in great numbers and variety. The ceiling was painted to give the impression of looking up through the ocean from a considerable depth. Another recollection is of an abundance of champagne served from pitchers in several marquees scattered about the beautiful grounds.

PROVOST: On the evening of Monday, the party assembled in the theater of the Institution of Civil Engineers to express by appropriate resolutions the overwhelming sense of appreciation felt by the party for the cordiality shown by their brother engineers of the United Kingdom, and for the hospitality so widely extended for their entertainment and instruction. Before the party left London, some twenty of these resolutions, suitably engrossed and signed by the officers, were forwarded. Such acknowledgments were tendered to the Queen, the Archbishop of Canterbury, the Mayor and Council of the City of London, and the Institution of Civil Engineers, as well as to the several municipalities, industrial organizations, and individuals to whom the party was so greatly indebted.

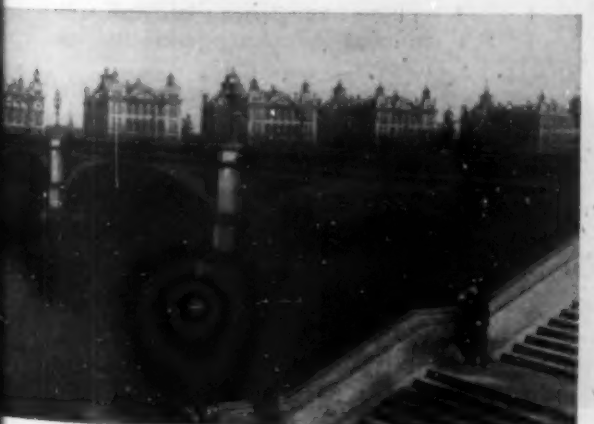
About this time, Folwell and I, noting that the camera count of exposures made was complete, left the film to be developed and forwarded with prints to us in Paris. The many scenes we had photographed occupied our thoughts and made us impatient to have them before us

English weather in June was then not urately visualized in America. My a had been that it would prove to be ch like that in New York. Accordly, the last day on shipboard, an unually pleasant day, I made the room ward a present of my overcoat. A days later, the purchase of another t became a wise procedure. For the ater part of our stay in England the ather was cold, cloudy, misty or wery, as it happened to take the cy. I can now recall but one perfect y, that of the garden party of the roness Burdett-Coutts.

It is to be presumed that we were en the best of English food. I can w recall nothing about it except gooseberry tart served with heavy et cream at Leamington. Experie with our small, sour gooseberries at home had given no inkling that such large, sweet, and entirely luscious oseberries existed anywhere. As for beverages, champne was served at all the English receptions, dinners, cheons, and garden parties, and it would appear doubtthat many of us have ever since seen it so freely and ually dispensed. In our contacts with the general blic, we noticed that ale seemed to be the standard tional drink.

English male attire at that time was apt to be more mal on informal occasions than in America. Many of r hosts always wore high hats. This badge of gentility s supposed to exact precedence in the shops and to inase deference elsewhere. In a weak moment some of fell for it—hence our first toppers. How soon were y to be consigned to obscurity! It was the period, o, when wide, bright stripes were fashionable in men's users. Having the address of a recommended tailor, as persuaded to order some that were particularly concuous. It just happened that a college friend, of my e and build, visited the same tailor and was fitted for a r from the same bolt of cloth. Upon our later joint pearance, in top hats, cutaways and identical loud users, we must have suggested a pair of transformed omios.

On the morning of Thursday, June 20, a special train m Victoria Station took the party to Dover for emkation to France. The President, Secretary, and a mber of leading members of the Institution of Civil gineers accompanied us on the train trip. At Dover, rass band was on hand to salute the party with several erican airs.



WESTMINSTER BRIDGE, NOTED THAMES RIVER STRUCTURE

© Will F. Taylor

WINDSOR CASTLE FROM ACROSS THE THAMES
Objective of a Delightful All-Day Excursion

THOMSON: We youngsters were also greatly impressed by being received by such a dignified group of white-haired engineers, who presented flowers to the ladies, and, when we were about to sail for France, a basket of strawberries to each lady of our party. This reminds me that I had never seen such hothouse grapes as we saw in England.

FRENCH: In a letter home at that time I wrote, "All of us carried away a much higher esteem of our hosts and a feeling of considerable obligation. Our visit will always be a red-letter week for all of us."

From the day of our landing at Liverpool on June 6 to our departure from Dover on June 20 (with the exception of the intermediate tours arranged for the Whitsuntide recess), all transportation on English railroads was free of charge. Lunches were served on many of our sightseeing trips, and we were of course royally entertained at the Liverpool reception and London Guildhall Dinner.

PROVOST: Looking back from the deck of the packet in the late afternoon, as the shore line of England faded, it was natural that the anticipation of future adventures could not wholly overcome the regret we felt at leaving a country where the hospitality had been so generous.

I am grateful for having been permitted to witness and enjoy the welcomes and attentions extended by the English people. The impressions then created have remained unchanged throughout the years. The efforts made by our hosts, and those we met, for our entertainment were no mere gestures. All their kindnesses were so spontaneous and friendly that, whatever our preconceived opinions might have been regarding the measure of cordiality existing between our country and England, no one who shared the experiences of the trip would be justified thereafter in regarding the English people except as most friendly and desirable neighbors; or feel that their generous attentions were other than full-hearted tributes to our great country and to the recognized achievements of her professional engineers. It may very well be that this trip, one of the earliest, no doubt, of the good-will meetings with our English neighbors, accomplished through the contact of international personalities, its full share toward the establishment of the friendly and cooperative relations that have existed between the two countries these many years.

Our recollections of English hospitality emphasize the regret recently felt by all American engineers when the return visit of their English confrères, planned for the fall of 1939, had to be canceled because of the war. It would have been a most fitting privilege to return the gracious courtesies extended just fifty years previously.

Effect of Temperature on Flow of Oil Through Small

Engineers' Notebook

Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems

Barge Builders Protected by Roofs on Wheels

By A. E. Niederhoff, Assoc. M. Am. Soc. C.E.

Chief Engineer, Marine Division, Bellingham Iron Works, Bellingham, Wash.

Construction of a series of steel barges for the Navy provided the Bellingham Iron Works, of Bellingham, Wash., with opportunity to try several cost-saving and time-saving strategems. The first ten barges had been assembled on ways in the open. Bad weather caused many delays, often stopping work completely.

Even after the weather cleared, considerable time would be lost drying out welding seams with a gas torch and then wire-brushing to remove the oxide. The obvious answer to the problem was to roof over the barge ways and the sub-assembly area.

A bridge crane of 7-ton capacity was purchased and erected over the sub-assembly jigs and fixtures. A wood shed consisting of a trussed roof and sloping sides was built next so that the bridge crane and all production served by the crane was protected from the elements.

The problem of roofing over the barges while they are under construction was not quite so simple. Production operations call for a crawler crane with a 60-ft boom to come alongside of the building ways and place 6-ton sub-assemblies onto the hull of the barge. A fixed roof was out of the question. A movable roof mounted on roller-bearing wheels was therefore designed and so devised that it could be pushed over a barge during inclement weather and pulled off when it cleared up, or when the crawler crane had to place sub-assemblies on board. Two movable roofs were made with a bowstring truss span of 48 ft, and each unit measured 68 ft long.

The roofs are high enough to go over the entire hull and deckhouse of a barge. A steel framework is covered with wood shiplap, and the entire unit rolls along a railroad rail on the ground. The two-wheel, roller-bearing trucks can swivel on a vertical pin and thus operate over track that may be misalined. A horizontal pin connecting the columns to the trucks compensates for track that may have settled below grade. Flexibility and equalizing features built into the trucks have paid dividends because the track over which the roof operates is neither in line nor to grade.

Production Line on Wheels

Elimination of the side-launching shipways and extension inland of the end-launching ways placed all barge construction in one straight line. The plan evolved was to make a building ways some 500 ft from the shore line. At this point (called Position 1) the bottom plates, prefabricated bulkheads, and wide transverse frames, as well as the barge sides, were fitted and fastened. Four specially designed, two-wheel trucks, operating on a railroad track of extra-wide gage, were welded to the bottom of the barge and the whole unit pulled oceanward about 150 ft to Position 2. Here the bilge plates were put on, the upper deck welded in place, and the framework of the deckhouse hoisted on board in prefabricated units. During this time, bottom plates were being placed and construction was proceeding on the next barge at Position 1.

From Position 2 the barge was rolled along the track to the launching point, or Position 3. Cleaning, painting, placing of towing bitts, roller chocks, and completion of the deckhouse took place at this point. The welding of the trucks to the barge was then chipped off and the barge lowered by the supporting jacks onto the launching shoes. Launching was done on greased sliding ways in the conventional manner.

Advantages of Improvements

Mounting the barges on wheels has saved considerable money formerly spent on launching grease and rigging labor. A barge can be moved along the rails by an ordinary automobile engine at a speed of 3 miles an hour. The blocks and tackle involved in former moving of the barges resulted in a speed of less than a half mile an hour. When the contract is finished, the salvage value of the trucks and rail will be high, whereas launching grease once used is gone forever.

The steel yard now has a production line for barges with a rail top flush with the grade of the yard. Trucks and crawler cranes pass over the rails easily and without injury. The sub-assembly building parallels the production line and is adjacent to it. Protection of workers from the elements has resulted in increased production and higher employee morale. Increased production per man and rapid completion of contract work have resulted. Formerly it was difficult to hold on to welders and fitters, but the company is now faced with the difficulties of laying off workers.

Barge and Shed Mounted on Wheels for Flexible Operation

Effect of Temperature on Flow of Oil Through Small Steel Pipe

By Anthony Hoadley, Assoc. M. Am. Soc. C.E.
Professor of Civil Engineering, Union College, Schenectady, N.Y.

EFFECT of viscosity on the flow of liquids can be effectively shown by the use of a simple and relatively inexpensive setup for measuring pressure loss in a small pipe line such as has been recently installed in the hydraulics laboratory at Union College. The general arrangement of the pipe line, heating tank, and weighing tank is shown in Fig. 1. At first two sizes of pipe were

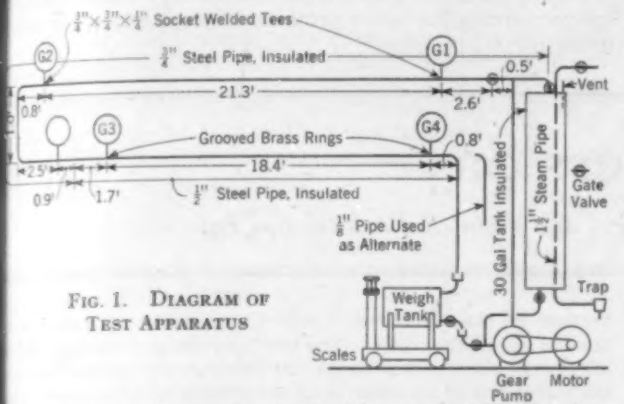


Fig. 1. Diagram of Test Apparatus

used to increase the range of velocities so that both turbulent and laminar flow conditions could be observed. Later an 18-in. length of $^1/_8$-in. pipe was added to the line to further increase the velocity range.

A light lubricating oil (SAE-10) was used in the experiments. With a flow of 5.5 gal per min, the pressure loss was 12.0 lb per sq in. in the 21.3-ft length of $^3/_4$-in. pipe and 4.7 lb per sq in. in the 18.4-ft length of $^1/_2$-in. pipe, the temperature of the oil being 72 F. At 210 F, the corresponding losses became 2.5 lb per sq in. and 1.0 lb per sq in. The striking change in the oil from a slow-flowing liquid at room temperature to a liquid which seemed to flow almost as freely as water at 210 F could be observed by the students as they drew the oil from the weighing tank to the pump receiver.

Apparatus Used

Oil flows by gravity from the heated storage tank to the gear pump, which has a constant rate of discharge of 5.5 gal per min. It is then pumped to the horizontal run of $^3/_4$-in. pipe, which is valved so that part of the flow

Table I. Test Data for Laminar and Turbulent Flow

	$^1/_8$-In. Pipe			$^1/_2$-In. Pipe			$^3/_4$-In. Pipe		
Temp., F	Vel.*	Loss†	R	Vel.*	Loss†	R	Vel.*	Loss†	R
220	....	....	....	6.4	0.114	6,300	3.6	0.047	4,770
170	15.2	2.7	3,130	3.02	0.054	1,370	...	....	....
170	30.4	8.3	7,000	6.3	0.179	3,160	...	....	....
91	7.4	2.6	319	5.0	0.36	489	...	....	....
91	30.3	13.3	1,340	1.4	0.11	138	...	....	....
71	....	....	....	6.0	0.76	347	3.4	0.25	263
71	....	....	....	2.8	0.32	160	1.6	0.10	121

* Velocity, in ft per sec.
† Loss, in lb per sq in. per foot.

can be recirculated to the storage tank. The test sections of pipe are connected by socket-welded fittings whose inside diameter is equal to the bore of the pipe. While these fittings are expensive, they cut down turbulence losses.

Pressure gages No. 1 and No. 3 were located approximately 50 pipe diameters downstream from the preceding fitting to avoid the effects of local turbulence. Gages Nos. 1 and 2 were attached to the $^3/_4$-in. pipe by the use of $^3/_4$-in. by $^1/_4$-in. socket-welded T's. The other gages were attached to brass rings which were brazed to the $^1/_2$-in. pipe. A groove was turned on the inside of each ring and four holes $^1/_{16}$ in. in diameter were drilled in the pipe wall so that the oil could flow from the pipe to each collecting groove and then to the pressure gage. The pressure gages could be read to the nearest $^1/_4$ lb. The tank was heated by steam, the steam running through a vertical length of $1^1/_2$-in. pipe, which was slipped through holes cut in the head and bottom of the tank and then welded in place. Both the tank and the pipe line were covered with insulation. A drawoff valve in the side of the tank is convenient for obtaining samples to check the temperature and specific gravity of the oil.

Results Obtained

The results of the experiments on three sizes of steel pipe—$^1/_8$ in., $^1/_2$ in., and $^3/_4$ in. in nominal diameter—are summarized in Fig. 2, which shows the friction factor, $f (h' = flv^2 \div 2gd)$ plotted against the Reynolds number **R** ($\mathbf{R} = Vd \div$ kinematic viscosity). In the region of laminar flow the experimental results for all three pipes seem to agree reasonably well with the theoretical relation $\mathbf{R} = 64 \div f$, which has been shown as a solid line. The critical point would seem to be at $\mathbf{R} = 1{,}200$ for the $^1/_8$-in. pipe, and at $\mathbf{R} = 1{,}500$ for the $^1/_2$-in. pipe, although it must be admitted that the experimental data do not show whether the individual points correspond to upper or lower critical velocities.

The dashed line in Fig. 2 shows the regular decrease of the friction factor for the $^1/_8$-in. pipe as **R** increases from 1,200 to 7,000. The $^1/_2$-in. pipe has a nearly constant friction factor of 0.038 for **R** values greater than 2,000. Under conditions which produced turbulent flow in the $^3/_4$-in. pipe, the measured pressure loss was only 1.0 to 1.25 lb per sq in., so that a relatively large error might be expected because of the limitations of the gages used. This would account for the scatter of the experimental

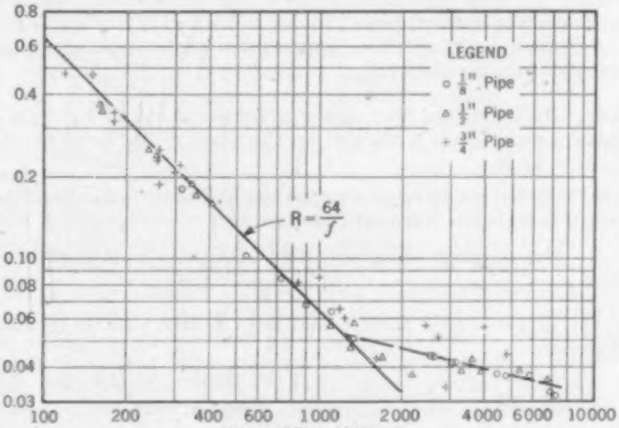


Fig. 2. Test Record of Relationship Between Friction Factor and Reynolds Number

points for the $^3/_4$-in. pipe in the region of turbulent flow.

The range of conditions covered is shown in Table I. The $^1/_2$-in. pipe was the most satisfactory in giving both turbulent and laminar conditions of flow. The pressure losses in the $^3/_4$-in. pipe were too small to be satisfactorily measured when the flow was turbulent. The $^1/_8$-in. pipe was interesting in that it gave an opportunity to observe flow at velocities up to 30 ft per sec and pressure losses as high as 13.3 lb per sq in. per foot, with oil at 91 F.

MEASURING VISCOSITY OF THE OIL

In computing the Reynolds number, it was necessary to know the kinematic viscosity of the oil at the temperatures used. A viscosimeter meeting the standards of the American Society for Testing Materials was used to determine the viscosity of the oil in Saybolt seconds, and the kinematic viscosity was then computed. Another interesting way to get the viscosity of the oil is to compute it from the relation for laminar flow:

$$\text{Kinematic viscosity} = \frac{gd^2\,h'}{32\,lV}$$

Loss of head–velocity curves were plotted for several series of constant temperature runs. These gave straight lines in the region of laminar flow. The viscosity was then computed from the loss of head and velocity values for a point falling on this line.

The setup which has been described has satisfactorily performed its main function of enabling us to study easily both laminar and turbulent flow of oil. The use of pressure gages with a range of zero to 30 lb per sq in. made the measurement of pressure loss simple and relatively foolproof. The test results have shown that manometers or precision pressure gages with a low range should be used for measuring the lower pressure losses, particularly when using the $^3/_4$-in. pipe.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Mexican Water Treaty—A Correction Is Offered

TO THE EDITOR: I read with much interest the article in the "Society Affairs" department of the December issue entitled "A Water-Utilization Treaty with Mexico."

As a member of the Committee of 14 and 16 of the Colorado River Basin during the past six years, acting as one of the representatives of the State of Wyoming, I have attended all the meetings in reference to this pending treaty that have been participated in by representatives of the states and of the U.S. Department of State. While the article is well written, it seems to me that it is not "impartial" and does not "represent a factual appraisal of the situation," as the editorial foreword states.

For instance, following the outline with reference to the Rio Grande, the article states, "It is apparent that United States interests are substantially favored in this arrangement"; and under the heading, "Apportionment of Colorado River Water," "it appears that in the apportionment of the waters of the Colorado River the arrangement is especially favorable to Mexico." These are the types of argument that might be used by one state to show that another state is being favored at its expense. In my opinion neither statement is in accord with the facts. Also the treaty does not confer upon the International Boundary and Water Commission nor upon the United States section thereof the broad powers implied by the article.

Factual items that I have in mind that would have added materially to the article are:

1. The treaty has been approved by five of the seven states of the Colorado River Basin and by the State of Texas of the Rio Grande Basin.

2. Mexico would receive more than half of her allocation from return flows below Imperial Dam.

3. Mexico is now using more than 1,500,000 acre-ft of water per year.

The article is on a subject that is of timely interest to many engineers.

L. C. BISHOP, M. Am. Soc. C.E.
State Engineer

Cheyenne, Wyo.

[*Editor's Note:* Comments supporting both sides of this question have been received, and exceptions similar to Mr. Bishop's have been raised by other members who indicate that the views expressed in the December CIVIL ENGINEERING are matters of opinion rather than fact. The sole purpose of the article was to inform the membership about this treaty in an impartial manner. Since it is not to the interest of the Society to take sides in such matters, the two excerpts quoted by Mr. Bishop may well be considered to have been omitted from the original article in order that it may be in truth what it was intended to be—a factual presentation.]

Trigonometric Solution Suitable for Logarithmic Calculation

TO THE EDITOR: The periodicity of the three-point problem, which is the subject of Professor Eves' article in the January issue, seems to be about thirty years. I first met it in 1887 while in the

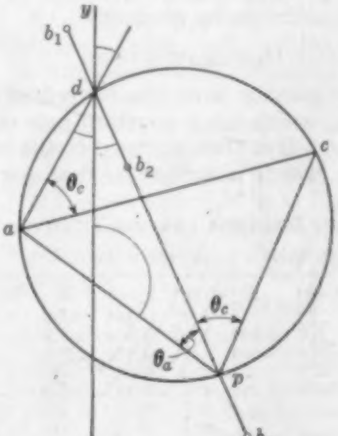


FIG. 1. GRAPHICAL EXPRESSION OF THE THREE-POINT PROBLEM

surveying school at "Camp Columbia" on Bantam Lake, Conn. Our textbook was Davies' *Elements of Surveying*, which said: "This problem is much used in maritime surveying, for the purpose of locating buoys and sounding boats. The trigonometrical solu-

is somewhat tedious, but the geometrical solution is very easy." paid little attention to it.

My second meeting with the problem was in the Coast Artillery ing the first World War, when the Lefax Society published eral solutions on four loose-leaf sheets, sponsored by the Coast illery School at Fort Monroe, Va. These were reprinted in 4, without revision. And now, in January 1945, I read Professor Eves' mechanized attack on my old acquaintance!

Many of us have no calculating-machines, and are thus obliged depend on our logarithms. Perhaps some of these unfortutes may be interested in the solution that follows. (The ple geometrical principle is found in Euclid, III, 21.) Reing to the accompanying Fig. 1, it is apparent that the e connecting the map images of any two field points is a rd of a circumcircle, and the map image of P is a point on e segment. The three field points and the two observed les originate three such circumcircles intersecting in a common int p.

Let a, b, and c be the map images of the three field points A, B, d C. b can occupy three possible positions in relation to a and as b_1, b_2, and b_3. θ_a and θ_c are observed angles from P, the obvation point. In the case of b_3, these angles are the supplements the observed angles. To find the map image of P, with the own distance ac and the angle apc, compute the diameter of the rcumcircle.

$$\text{Diameter} = \frac{ac}{\sin apc}$$

Then plot the center with radii from a and c and describe a circle. mpute ad = diameter $\times \sin \theta_a$; plot point d on the arc. Then line drawn through d and b will cut the arc of the circumcircle p, the required point.

In calculating the coordinates of p, angle dac = angle θ_c (subding arc dc); Y azimuth of ad = Y azimuth of ac − angle θ_c; d with azimuth and length of ad compute coordinates of d. hen from coordinates of d and b, compute Y azimuth of dp. ngle adp = Y azimuth of ad + (180° − Y azimuth of dp). ap = ameter $\times \sin adp$, and Y azimuth of ap = Y azimuth of dp − ngle θ_a. Finally, with Y azimuth and length of ap, compute the ordinates of p.

In Professor Eves' Fig. 1, two of the three circumcircles are used to termine p. This is sometimes called the "common chord solution." Although apparently quite involved, it is especially adapted to calculating-machine methods.

In my solution I used the third circle only, with the chord ac. Although geometrically simply, I am told that it would require more work on a machine. I have had no experience with calculating-machines—they were coming in as I was going out.

ALGER C. GILDERSLEEVE, M. Am. Soc. C.E.
Far Rockaway, N.Y.

Comments on Spanish Transportation Problems

DEAR SIR: Mr. Kirkpatrick's letter about the late J. F. Stevens in the November 1944 issue of CIVIL ENGINEERING, and that of Philip W. Henry, in the January 1944 number, give impressions of the late King Alfonso of Spain which differ considerably from my own.

In 1917 I made a reconnaissance survey and economic study for a "direct" railway from Madrid to France. I also looked into some other transportation problems in Spain at that time. All of these I discussed with the king, and I found he had a better than average grasp of what it was all about and how it might affect the economic development of Spain.

At that time Joseph E. Willard, who had previously been a railroad commissioner in Virginia, was ambassador to Spain and a close personal friend of the king. The United States had, therefore, a unique opportunity to interest itself in some of these projects, but there was no spirit of adventure then, and no adventure capital was available. As a matter of fact, I doubt if there is today, and that is why I am afraid that all our talk of interest in foreign trade will get us nowhere today, as it did in the postwar period after the armistice of 1918.

We need gentlemen adventurers and adventure capital—not loans or bribes or charity but capital which ventures into enterprises in foreign countries, backed by men of knowledge. Until we develop this idea we shall get nowhere with foreign trade or enterprise.

New York, N.Y. FRED LAVIS, M. Am. Soc. C.E.

Forum on Professional Relations

CONDUCTED COLUMN OF HYPOTHETICAL QUESTIONS WITH ANSWERS BY DR. MEAD

For over two years now Dr. Mead has been answering questions on engineering ethics in these columns. In the current issue he gives his answer to Question No. 30, which was announced in the January issue of "Civil Engineering." The question reads as follows: "An engineer was employed to design and supervise the construction of a plant. While the construction was in progress he made suggestions to the contractor regarding his methods employed, with the result that the contractor received a larger profit. After final payments had been made to the contractor and engineer, the contractor offered the engineer a reward for his suggestions. Should the engineer accept or reject?"

The writer would feel that he should not accept remuneration for any suggestion he could make to the contractor that might legitimately reduce the cost of his work. On the other hand, if the engineer in question was perfectly honest in his relations with both the contractor and his principal, I would hardly feel that is was entirely unethical for him to accept remuneration for valued suggestions after the work was completed—provided of course, that he had no further work to supervise which the same contractor was to perform. The acceptance of remuneration of this sort would probably tend to make the engineer feel under obligation to the contractor, which would be undesirable if he were to continue supervising that contractor's work.

Personally, the writer would feel under obligation to assist the contractor in completing his work as well and as economically as possible, and would not feel that he could accept remuneration therefor.

DANIEL W. MEAD, Past-President and Hon. M. Am. Soc. C.E.
Madison, Wis.

Question No. 31, which was announced in the February issue, will be answered in the forthcoming, or April, number. Next in the series, the following question is announced. Replies may be received until April 5, with answers in the May issue.

QUESTION NO. 32: *A large firm of consulting engineers opened a branch office in a smaller town, where much future work was being contemplated, and they placed one of the junior members of the firm in charge. In the course of two years the new business, growing out of the construction of a new sanitary sewer and water system, was given to the engineering firm without competition. However, when a large $800,000 paving project came up, an outside firm specialising in paving came in and, at the proper time, underbid the local firm and completely convinced the town of its superior ability to do the work. The local firm had, without solicitation, made many preliminary surveys, plans, and estimates in the hope of getting the work in question. This firm did not specialize in paving, but had made a fine record doing some difficult paving in towns located in the mountains.*

Granting that the firm specialising in paving was better equipped to handle the job, was it ethical for it to come into the town where the other firm had established itself and gone to no little expense and effort to make a good record?

SOCIETY AFFAIRS

Official and Semi-Official

Local Sections Conference Held in New York

Report of Meeting by Chairman of the Society's Committee on Local Sections, Francis H. Kingsbury, and his committee, Lloyd D. Knapp, Robert M. Angas, and Fred H. Rhodes, Jr., Secretary

THE Local Sections Conference was opened at 9:30 a.m., January 16, in Room 1001, Engineering Societies Building, by Francis H. Kingsbury, chairman of the Committee on Local Sections. Representatives from 24 Local Sections, all members of the Committee on Local Sections, and several visitors, were present. A hearty welcome was extended to the group by William McK. Griffin, president of the Metropolitan Section.

The morning session was devoted to the subject of collective bargaining. Howard F. Peckworth, Assistant to the Secretary of the Society, recited the history which influenced the Board of Direction to recommend to the Local Sections a program for improving the economic status of the engineer. He explained the method by which the Local Sections might form collective bargaining groups, and reviewed the actions taken by the Local Sections, 30 of which have voted to act in accordance with the plan proposed by the Board of Direction. Other engineering societies have joined the American Society of Civil Engineers, in the formation of a Joint Committee to make further studies of methods for improving the economic status of the engineer.

Henry L. Thackwell, West Coast Field Secretary, told of the need for professional bargaining groups and of some of his contacts with employers. He said that, in many instances, employers have stated that engineers are handicapped, financially, because they are not prepared to bargain collectively.

Each representative was asked to report the action taken by his Local Section in regard to collective bargaining. It appeared that generally the Sections felt that the economic status of the engineer must be improved, but that it must be done in a professional manner. Some Sections approved the Board's recommendation for forming collective bargaining groups, while others did not, but instead formed committees to investigate conditions in their areas. Others felt that there was no need for bargaining and opposed the formation of such groups.

A discussion of the Wagner Act disclosed the fact that if the Act were amended to exclude professional employees, it would merely deny to those employees the right of hearing before the WLB and NLRB. The basic right of collective bargaining, it was stated, is a constitutional right which cannot be denied to any specific stratum or class of society. In Canada a concerted appeal to the Canadian War Labour Board has been made for the adoption of a collective bargaining act for the professions. Such an act has been drafted, and in many ways it follows the wording of the present Canadian collective bargaining law, which in turn parallels the Wagner Act.

Following Mr. Pirnie's afternoon address, referred to later, the subject of collective bargaining was resumed in order to hear from all the representatives of the Local Sections. It was the general feeling that other engineering societies should join in the movement because the need is not confined to civil engineers.

The afternoon session was opened with an address by President Malcolm Pirnie, who reviewed the past year's accomplishments, particularly in postwar planning. In this connection, Mr. Pirnie's activity will not end with his term as President of the Society, as he will serve as chairman of an Action and Advisory Committee to assist the Committee for Economic Development in stimulating the preparation of postwar construction at the community level, particularly in terms of private construction.

The subject of Postwar Construction was covered very thoroughly by Mark B. Owen, representing the Society's Committee on Postwar Construction. Both speakers on postwar planning emphasized that it is up to the Local Sections to make the plan work—the national committee acting as clearing house and coordinator.

Evaluation of Professional Objectives in the Design of Sanitary Engineering Works

Progress Report of Committee of the Sanitary Engineering Division, January 1945

THE COMMITTEE on Evaluation of Professional Objectives in the Design of Sanitary Engineering Works was appointed by the Executive Committee of the Sanitary Engineering Divison in 1944. The assignment of the Committee is "to evaluate the professional objectives of engineering in designing water purification and sewage treatment works with reference to the influences of proprietary equipment and processes upon the development of effective and economical plans that will best meet the need of the community or industry to be served."

In further explanation of the assignment to the Committee, the Executive Committee states: "The situation existing at this time in the purification of water and sewage, due to the many processes that are being used, many of which are covered by proprietary patents and actively promoted commercially, has caused serious problems that will at the same time provide sufficient competitive conditions to assure lowest costs to the owner.... In its investigations, the Committee may properly give consideration to relative effectiveness of different processes, conditions where certain of them would be especially well adapted, and any other features having not only direct but collateral bearing upon its recommendations and suggestions leading to a more intelligent handling of water purification and sewage disposal from the standpoint of effective service to the public by the engineering profession."

The request for the formation of the Committee appears to have arisen mainly as a result of the growing practices, by promoters of patented processes or equipment, of controlling or limiting by the use of patents the selection of treatment processes for water and sewage; and of selling direct to clients with engineering services furnished free, thus by-passing engineers in private practice.

One of the Committee's first tasks was to agree upon the scope of its activities and to attempt to set definite objectives. The assignment to the Committee makes no distinction between water and sewage treatment works for the public agencies and such works for private industry. While the Committee believes that its appointment arose primarily from practice trends in public works, it nevertheless feels that its studies and recommendations should include private and industrial sanitary engineering works. An important distinction must be drawn between these two classes of works because of the fact that competitive bidding is required by law on public works and is not so required on private works.

The absence of legal restrictions on the award of contracts for private sanitary engineering works has favored a rapid growth in the use of patented processes and equipment. In seeking new outlets for their businesses, it is quite natural that promoters should extend to public works business practices which have been successful in private works.

The Committee feels that there are three interests involved in the matters to be studied by it, namely, the client, the professional engineer, and the promoter of the proprietary processes and equipment. The Committee is a creature of this Society and this report

st obviously be directed to the members of the Society. While hoped that the report may influence the actions of clients and moters, it can only do so if it makes recommendations which are antageous to these interests.

he Committee expects to continue its deliberations during the ning year with the hope that a constructive report can be submitted at the next Annual Meeting. In the meantime the Committee solicits assistance from all who are interested in this problem.

For the Committee,

PROF. DON E. BLOODGOOD F. M. VEATCH
WELLINGTON DONALDSON FREDERICK H. WARING
THOMAS R. CAMP, *Chairman*

Metropolitan Section Promotes Postwar Construction Conference

COOPERATING with other professional and industrial organizations, the Metropolitan Section of the Society took an active part promoting a Conference on War Production and Future Planning, held in New York City on January 30. The particular product of the Section's energies was a panel discussion on postwar construction.

Indicating the success of such joint efforts was the large attendance of both engineers and representatives of industry. Speakers expressed the viewpoints of both the engineering profession and industry. Chairman of the Society's Committee on Postwar Construction, G. Donald Kennedy, gave a concise account of the engineering profession's desire to complete plans for needed works before the end of the war so that a long and disastrous transition period of inactivity can be avoided.

The attitude held by industrial leaders was stated by C. Scott Fletcher, National Executive Director of the Committee for Economic Development. Mr. Fletcher stressed the need for 55 million productive civilian jobs after the war. He said, "Never again will doles and subsistence levels be tolerated. Jobs for returning soldiers and sailors and war workers must be provided primarily through the resources and ingenuity of business, or the government will be forced to take over."

Especially interesting is this endeavor of the Committee for Economic Development in view of the Society's active participation in that organization. Representing the Society in C.E.D. affairs is Past-President Malcolm Pirnie, who is serving as Chairman of Action and Advisory Committee No. 20 of the organization. Members of the Society's Committee on Postwar Construction also served on this C.E.D. Committee. (See CIVIL ENGINEERING for January 1945, page 48.)

Other speakers on the panel discussion were Wm. McK. Griffen, President of the Metropolitan Section, Am. Soc. C.E.; Sydney L. Strauss, President of the N.Y. Society of Architects; Arthur C. Holden, President, N.Y. Chapter, American Institute of Architects; and Harry R. Kessler, Chairman, Program Committee, American Society of Mechanical Engineers.

Chairman of the panel was Irving V. A. Huie, Past-President of the Metropolitan Section. Also representing the Metropolitan Section on the Committee arranging for the conference was W. J. Shea, Secretary of the Section. Altogether seventeen organizations and the War Production Board cooperated in the conference.

Report National Research Council

Activities of the Division of Engineering and Industrial Research of the National Research Council, from June 1 to December 31, 1944, are reported at the close of the year by W. F. Durand, Chairman of the Division. Past-President F. H. Fowler represents the Society on this Division. A condensation of the report follows.

War Metallurgy Committee. Work in the field of metallurgy has continued to represent our largest activity. A recent summary report as of date, December 1, shows 54 projects active on that date, others having been either completed or terminated. In connection with these various lines of metallurgical research, 757 reports had been prepared and submitted to the appropriate authorities.

Quartermaster Corps Projects. Projects from the Quartermaster have continued to come in during the past six months in considerable numbers. It will be recalled that these projects cover the widest range of subject matter, call for expert treatment of the widest range, and apparently give us opportunity to be of service of great importance to the armed forces in matters affecting the comfort, health, and efficiency on the fighting fronts.

Committee on Fatigue in Industry. In previous reports, reference has been made to our activities relative to the general subject of fatigue in industry and of the appointment of a committee of the Division to act in a broad advisory and exploratory way with reference to such activities in this connection as might appear to be promising of useful results. Since these earlier reports, two subcommittees have been organized: first, a subcommittee under the chairmanship of Dr. Robert S. Goodhart of the War Food Administration, charged with the project of the preparation of a summary manual on the subject of nutrition in industry. This manual is intended to summarize in brief and easily understandable form the results of recent experimental work on this subject. The manual is intended for wide distribution in industry and especially for the benefit of small industries, the executives of which have presumably little or no information regarding this subject. It is believed that such a manual would be of distinct value in the general field of industry, calling attention to the importance of proper nutrition for industrial personnel and setting forth ways and means whereby management may contribute most effectively toward the realization of a balanced and well-organized diet for the industrial worker.

Highway Research Board. At the request of the Office of Defense Transportation, the Fall Meeting of the Highway Research Board was postponed.

The monthly publication, *Highway Research Abstracts*, has been issued as usual and in addition Vol. 23 of the *Proceedings* has been published, comprising 600 pages with 48 technical reports. Also, there has been issued the Roadside Development Report comprising 147 pages with 20 reports. The ninth bulletin of Wartime Road Problems, "Treatment of Icy Pavements," was also distributed in November. Two further bulletins—No. 10, on "Salvaging Old High-Type Flexible Pavements," and No. 11, on "Compaction of Subgrades and Embankments"—are ready for printing.

A new special project in cooperation with the Calcium Chloride Association on the "Use of Calcium Chloride in Soil Stabilization" is under way.

A meeting of the Maintenance Department of the Highway Research Board was held in Cincinnati on November 27. On November 29, Director Roy W. Crum, M. Am. Soc. C.E., attended the meeting of the Committee on Research Activities of the American Association of State Highway Officials, of which he is secretary.

Surplus War Properties Administration. Early in November last, Mr. W. L. Clayton, at that time Administrator of this Administration, requested the aid of the National Academy of Sciences in the study of certain scientific problems bearing on the plans of the Administration regarding the most effective disposal of surplus war properties, especially in the postwar period.

The particular field in which present aid was requested was in the disposal of surplus aeronautical material—airplanes and equipment. As most of the problems involved lie in the field of engineering, the various investigations to be carried out were allotted to the Division of Engineering and Industrial Research.

[For further information on any of these matters, address the National Research Council, 2101 Constitution Avenue, Washington 25, D.C.]

Traffic Film Made Available

A SOUND-SLIDE film, "Traffic Jam Ahead," has been added to the file of illustrative material available at Society Headquarters. This film, emphasizing the war intensified problems of traffic control and accidents, was prepared by the Committee on Postwar Traffic Safety Planning. It is available for showing at any Local or Section Student Chapter meeting and will be shipped on application from 33 West 39th Street, New York 18, N.Y.

Forty-two national organizations are sponsoring the Committee on Postwar Traffic Safety Planning, among them the Society. The film and sound record run for about 20 minutes. A sound-slide film projector (not a motion-picture projector) is necessary.

The Engineer in Foreign Service

XI. With an A.A. Battery in France

By CAPT. CHARLES K. WILLEY, JUN. AM. SOC. C.E.

"I AM EXPECTING a 10% pay cut before another year is out, resulting from a transfer back to the good old U.S.A. Did I say expecting, well, I meant just hoping, as from where I stand (with just my neck sticking out) it looks like we have a lot more hills and rivers to cross before Jerry yells 'Uncle' and dashes off into the woods.

"I am finding my difficulty in mastering the language quite a hardship. In all these months I seem to have picked up only a couple of words. One of these naturally is 'Oui.' Quite a few times I find myself using it unwittingly when the proper answer should have been 'non.' Guess the main reason I didn't pick up French is at first I didn't think I would be in this country long enough to have much need for it and German would be of more use. Now I find it is of no use as we aren't allowed or rather I should say we weren't allowed to speak with them except with our typewriters (Chicago type). I got that silly idea about French when we were kicking up the dust so fast last summer. Dust! What am I saying! I haven't seen any dry dirt practically since coming to this sodden country. I always heard the French never drank water. Well, it's true; in fact they don't need to as they have ample opportunity to absorb enough through their skins for all normal needs. I have seen the sun in sunny France only twice.

"I haven't visited Paris but I visited Epinay, near Rheims. Here it was easily possible to get a bottle of vintage 1927 champagne for a pack of cigarettes or a can of 'C' ration hash. Of course a can of 'C' rations in France would get you anything.

"I also stuck my nose through some of the old forts in and around Verdun. I will be eternally grateful to the boys of the infantry and armor for sweeping Jerry out of there before I did my prowling. Of course I must be grateful to the infantry for a hell of a lot more things, and every man of every branch who doesn't take his hat off to the lowliest of the lowly doughboys is being disrespectful and not giving credit where credit is due. When it comes right down to it, they are the only ones who really win battles and wars, and the rest of us ride the gravy train and help out once in a while.

"I have an A. A. battery whose main function is to reemphasize the non-existence of the 'non-existent' Luftwaffe. However, I can readily assure you that this branch of Jerry arms still does exist and that our Army has taken quite a big bite out of him. Still he seems to be able to go back to the dentist and get fixed up every so often.

"As to engineering, one day I was standing by a movable dam watching the flood waters roll over and saw that hydraulic phenomenon known as a 'standing wave.' That has been the limit of my engineering experience since entering the service.

"If you, any of you, ever run out of a job in hydraulics there at the office I would appreciate your taking on a little research on finding out how to keep a 10-ton halftrack from sinking in this French mud. I haven't."

[*Condensed from January 1945 "Tennessee Valley Engineer," publication of the Society's Tennessee Valley Section.*]

Appointments of Society Representatives

CHARLES B. BURDICK, THEODORE L. CONDRON, and JOSHUA D'ESPOSITO, Members Am. Soc. C.E., have been appointed to act as a committee to prepare a memoir of ALONZO J. HAMMOND, Past-President and Hon. M. Am. Soc. C.E.

GEORGE W. BURPEE, M. Am. Soc. C.E., has been reappointed the Society's representative on the Executive Committee of the Engineers Council for Professional Development.

THURMAN W. DIX, M. Am. Soc. C.E., served as the Society's delegate at the inauguration of Homer Levi Dodge as president of Norwich University on October 9, 1944.

MALCOLM PIRNIE, Past-President Am. Soc. C.E., has been appointed a representative of the Society to fill the expired term of Past-President J. P. HOGAN on the John Fritz Medal Board of Award.

C. A. POHL, M. Am. Soc. C.E., has been reappointed the Society's representative on the Committee on Professional Training of the Engineers' Council for Professional Development.

News of Local Sections

Scheduled Meetings

CLEVELAND SECTION—Dinner meeting at the Cleveland Engineering Societies Club on March 16, at 6:30 p.m.

COLORADO SECTION—Dinner meeting at the Oxford Hotel on March 12, at 6:30 p.m.

MARYLAND SECTION—Dinner meeting at the Engineers' Club on March 22, at 6:45 p.m. (cocktails at 6).

METROPOLITAN SECTION—Meeting in the Engineering Societies Building on March 21, at 8 p.m.

MIAMI SECTION—Dinner meeting at the Southern Tavern on March 1, at 7 p.m.

MICHIGAN SECTION—Meeting program presented by the Huron Clinton-Metropolitan Authority at the Engineers' Society of Detroit on March 16, at 8 p.m.

NORTHWESTERN SECTION—Dinner meeting at the Campus Club on March 5, at 6:30 p.m.

PHILADELPHIA SECTION—Dinner and meeting at the Engineers Club on March 13—dinner at 6 p.m.; meeting at 7:30 p.m.

PROVIDENCE SECTION—Meeting in the Providence Engineering Societies Building on March 14, at 8 p.m.

SACRAMENTO SECTION—Regular luncheon meetings at the Elks Club every Tuesday at 12 m.

ST. LOUIS SECTION—Luncheon meeting at the York Hotel on March 26, at 12:15 p.m.

SAN DIEGO SECTION—Dinner Meeting at the U.S. Grant Hotel on March 22, at 6:30 p.m.

SAN FRANCISCO SECTION—Dinner meeting of the Junior Forum at the Engineers' Club on March 22, at 5:45 p.m.

TENNESSEE VALLEY SECTION—Dinner meeting of the Chattanooga Sub-Section with local groups of the other Founder Societies at the Ross Hotel on March 13, at 6 p.m.; dinner meeting of the Knoxville Sub-Section at the S & W Cafeteria on March 14, at 6 p.m.

TEXAS SECTION—Luncheon meeting of the Dallas Branch at the Adolphus Hotel on April 2, at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on March 12, at 12:15 p.m.

TRI-CITY SECTION—Dinner meeting at the Black Hawk on March 22, at 6:30 p.m.

Recent Activities

ALABAMA SECTION

The annual meeting of the Alabama Section took the form of a two-day session, which was held at the Thomas Jefferson Hotel in Birmingham on December 15 and 16. Following registration on the morning of the 15th, the group proceeded by automobile to the large modern plant of the American Cast Iron Pipe Company, where they had an opportunity to observe the processes of centrifugal casting and several improved methods of manufacture. A symposium on sectional bridges was the feature of the afternoon technical session. The production of these structures was discussed by Edwin T. McGowan, captain, Corps of Engineers, U.S. Army; the process of fabrication was described by H. A. Davies, manager of the Birmingham plant of the Virginia Bridge Company, and testing the structures was explained by Dewey M. McCain, head of the department of civil engineering at Mississippi State College. During the business meeting, held later in the afternoon, the following officers were elected for the coming year: A. Reese Harvey, president; T. F. Hobart, first vice-president; J. F. Tribble, second vice-president; and T. H. Milford, secretary-treasurer.

An informal dinner was enjoyed that evening, Section President Ralph A. Smallman acting as master of ceremonies. The after-dinner speakers were Acting Assistant Secretary James E. Jagger, who gave a summary of recent Society activities, and Nathan W. Dougherty, dean of engineering at the University of Tennessee, whose subject was "Postwar Engineering Education." Prof. James M. Faircloth, of the University of Alabama, and Dean J. E.

nnum, of Alabama Polytechnic Institute, discussed Dean ugherty's paper. A motion picture, entitled "155-mm Shell-rging Plant in Operation," was then shown through the courtesy the Tennessee Coal, Iron and Railroad Company. At nine lock the meeting adjourned so that the members and their sts could attend the Christmas dance of the Association of Iron d Steel Engineers. The list of speakers scheduled for the Sat-day morning session included H. E. Myers, of J. B. Converse d Company, Inc.; S. J. Cumming, division engineer for the abama State Highway Department; and E. N. Rodgers, as-tant director of the Alabama State Highway Department.

Buffalo Section

At the December 27th luncheon meeting of the Section the lowing officers for 1945 were elected: Harland C. Woods, presi-nt; Martin H. Brennan, vice-president; A. Stuart Collins, retary; and Louis S. Bernstein, treasurer. Another feature of e occasion was the presentation of a certificate of life member-ip to Charles A. Randorf, who responded with a short speech. o other new life members—Bruce Cushing and Theodore Green ere unable to be present and receive their certificates in person.

District of Columbia Section

A joint meeting of the District of Columbia Section and the ashington section of the American Institute of Electrical Engi-ers was held on December 12, with Maj. Gen. Eugene Reybold, ief of Engineers, U.S. Army, as guest speaker. General Rey-ld reported on the role of the American engineer in the war, point-g out that the tremendous engineer activity in all the theaters of ar has been of major importance in turning the tide of the war and the drive toward victory. At the conclusion of his talk two reels films showing the use of heavy construction equipment in break-g through and cleaning out landing barricades and pillboxes nstructed by the Germans on the Normandy beaches, were esented.

Georgia Section

A number of members and their lady guests attended the annual nner dance on December 12. The high light of the meeting pre-ding the festivities was the presentation of a certificate of life embership to Marion Reed Kays. The annual election of officers, o held during this session, resulted as follows: M. T. Thomson, esident; H. H. Perkins and F. W. Altstaetter, vice-presidents; d R. O. Harris, secretary-treasurer. At the January luncheon eting W. C. Cram gave an informal report on the activities of e Georgia Agricultural and Industrial Board, with specific ref-ence to the Industrial Panel, of which he is director.

Iowa Section

A joint meeting of the Section and the Student Chapter at Iowa ate College took place at Ames on February 6. A quarantine the Navy personnel made it impossible for any of the group to e present, so student attendance was limited to the civilian per-nnel. An illustrated lecture on the work of the Seabees, and of e 40th Construction Battalion in particular, comprised the chnical program. This was given by I. S. Rasmusson, com-ander, Civil Engineering Corps, U.S. Naval Reserve.

Kansas Section

On the evening of January 9 members of the Kansas Section ere guests of the Topeka Engineers Club. The principal speaker as A. J. Boase, of the Portland Cement Association, who gave an ustrated talk entitled "The Challenge of South American Re-forced Concrete Practice." Some very novel and daring design actices were presented. Although South American designers ork under a very flexible building code and use higher working resses of concrete and steel, they subject all designs to a very orough mathematical study.

Louisiana Section

Following a custom of twenty years' standing, the Section's nual meeting was held at the home of Ole K. Olsen. This year e date for the meeting was February 3, and the group as usual artily enjoyed Mr. Olsen's hospitality. The technical program nsisted of a talk by H. R. Bodemiller, chief engineer of the onomic Development Committee of Louisiana, whose subject as postwar planning for the city of New Orleans and the ate of Louisiana. The speaker at the January meeting was mes T. Mathews, rear admiral, Civil Engineering Corps, U.S. avy, whose talk was entitled "The Seabee Road to Victory."

Maryland Section

The list of guests at the January 26 meeting of the Section included the new Society President, J. C. Stevens, and George T. Seabury, Secretary of the Society. The former reviewed the recent activities of the Board of Direction, with particular reference to its stand on the subject of collective bargaining, while Mr. Seabury briefly discussed the Society's Committee on Postwar Construction. Mr. Seabury used his talk as a means of introducing Mark D. Owen, chairman of that committee, who gave a more detailed talk on the work of the committee.

Michigan Section

Representatives from the Student Chapters at the University of Michigan and University of Detroit were guests of the Section for its January dinner meeting, which took place at Ann Arbor on the 26th. During the business session certificates of life membership were presented to H. P. R. Jacobsen, Ezra C. Shoecraft, and Donald D. Smith. Each of the recipients responded with a short talk, after which the principal speaker of the evening, W. C. Steere, was introduced. Dr. Steere, who is associate professor of botany at the University of Michigan, spoke on "Searching for Quinine in the Andes." In his talk, which was illustrated with colored slides, Dr. Steere covered the two years he spent on location in Colombia and Ecuador, where he had been commissioned by the government to find and purchase quinine and ship it to this country.

New Mexico Section

The annual meeting of the Section took place in Santa Fe on December 19. The customary dinner was followed by a business session, which included the election of officers for 1945. These are Donald C. Bondurant, president; William G. Bratschi, first vice-president; Harold B. Elmendorf, second vice-president; and Ernest B. Bail, secretary-treasurer. Another feature of the occasion was the presentation of a certificate of life membership to Herbert W. Yeo, who replied with interesting reminiscences of his engineering career dating back to 1902. The technical program consisted of a talk by H. L. Thackwell, assistant to the Secretary, who discussed recent activities of the Society, especially in regard to collective bargaining.

Northeastern Section

Speakers and guests of honor at the annual meeting of the Northeastern Section—held in Boston on January 22—were J. C. Stevens, newly elected President of the Society, and George T. Seabury, Secretary. Mr. Stevens spoke on the subject of "Winning the Peace," while Mr. Seabury reported on the activities at Society Headquarters. Prof. Charles B. Breed, Director of the Society, was also present and spoke briefly. Certificates of life membership were presented to Robert E. Barrett, Richard K. Hale, James H. Hood, and Edward H. Howard. Recipients in absentia are James H. Duncan, Frank R. Lanagan, and Francis S. Wells. During the business meeting William M. Bassett was elected president; Harvey B. Kinnison, vice-president; and Howard J. Williams, secretary-treasurer.

Northwestern Section

The technical program at the February meeting of the Section consisted of a talk by G. R. Ramsey, vice-president of the National Pole and Treating Company, of Minneapolis, Minn. Mr. Ramsey spoke on timber treatment, describing the progress that has been made in preservative materials and methods used to counteract such destructive agencies as termites, teredo, and fungi. His talk was enthusiastically discussed from the floor.

Oklahoma Section

Various business matters were discussed at the January meeting of the Section, and a certificate of life membership was presented to Col. Webster L. Benham. A talk by H. G. Thuesen comprised the technical program for the occasion. Professor Thuesen, who is acting assistant dean of engineering and head of the department of industrial engineering at Oklahoma Agricultural and Mechanical College, spoke on the subject of "Job Design."

Oregon Section

New officers for the Oregon Section—elected at the annual dinner meeting held in Portland on January 5—are as follows: R. E.

Hickson, president; B. E. Torpen, first vice-president; C. B. McCullough, second vice-president; Gage Haselton, treasurer; L. J. Kelsh, secretary; and K. N. Phillips, assistant secretary. Following the presentation of a certificate of life membership to Horace E. Plummer, the speaker of the evening, Orlando John Hollis, was introduced. Mr. Hollis, who is acting president of the University of Oregon, gave an address entitled "An Unofficial Account of the Constitutional Convention of 1787." The presentation of a sound motion picture, "Engineering in Wood," concluded the technical program. The film was shown through the courtesy of Timber Structures, Inc.

Philadelphia Section

"Sanitation Problems of the Lower Delaware River" was the topic of discussion at the January 9 meeting of the Section. The principal speakers taking part in the symposium were James H. Allen, executive secretary of the Interstate Commission on the Delaware River Basin, who described the pollution problem of the Delaware and predicted the clearing up of this problem in a few years; Richard C. Beckett, state sanitary engineer of Delaware, who described the situation in that state; Howard E. Moses, chief engineer of the Pennsylvania State Department of Health, who discussed the pollution problem from the viewpoint of Penn ylvania; and John E. Allen, principal assistant engineer for the Philadelphia Bureau of Engineering, Surveys, and Zoning, who described the steps being taken by that city toward abating the pollution problem by treatment of its sewage. A paper prepared by Harry C. Croft, chief engineer for the New Jersey State Department of Health, was read by John Boardman in Mr. Croft's absence. At the beginning of the meeting a rising vote of thanks was given Prof. Scott B. Lilly, who has just completed a term as Director of the Society for District 4.

Pittsburgh Section

On January 10 the Pittsburgh Section held a joint meeting with the civil section of the Engineers' Society of Western Pennsylvania. The group heard A. A. Levison, manager of the construction equipment department of the Blaw-Knox Company, discuss the subject of construction equipment. At the annual meeting held on February 1, Society Director C. F. Goodrich reported on the Society's Annual Meeting in New York, and A. J. Ackerman discussed postwar planning. Mr. Ackerman is director of engineering for the Dravo Corporation.

Providence Section

Guests of honor at the January dinner meeting of the Providence Section were President Stevens, Secretary Seabury, and Walter H. Law, new life member from the Section. Mr. Stevens discussed the problems facing engineers today, while Mr. Seabury spoke on the collective bargaining situation. Harry Pope, the "Cape Cod Philosopher," then entertained the group with a fund of interesting stories interspersed with homely philosophy. In the afternoon the Section officers and Mr. Stevens were entertained at the Naval Construction Training Center at Davisville, R.I., through the courtesy of Capt. Fred Rogers and Comdr. A. D. Hunter, Civil Engineering Corps, U.S. Navy. After an inspection tour of the center Mr. Stevens was guest of honor at a reception given by the civil engineer officers on duty at the Base, who are also members of the Society.

Rochester Section

On January 5 the Rochester Section held its annual dinner meeting, at which the following new officers were elected: Harry W. Eustance, president; Vernon E. Warney, first vice-president; Philip F. Stephens, second vice-president; and Cecil Aronson, secretary-treasurer. The technical program consisted of a talk on the subject, "A Teacher Looks at Civil Engineering, Past, Present, and Future"—given by Prof. William A. Malcolm, of Cornell University.

South Carolina Section

The annual winter meeting of the Section was held in Columbia on January 24. This was a joint meeting with the South Carolina Society of Engineers and consisted of a luncheon, technical session, and business meeting. The list of speakers appearing on the technical program included Dr. Blake Van Leer, president of the Georgia School of Technology; Ole Singstad, chief engineer of the New York City Tunnel Authority; and Wesley H. Day, turbine engineer for the Shell Oil Company, of New York. During the business session the following officers for 1945 were elected: Lewis A. Emerson, president; C. P. Roberts, vice-president; and Albert E. Johnson, secretary-treasurer. Also, a resolution was passed endorsing the "South Carolina Coordinate System," adoption of which had been recommended by the Society.

Spokane Section

New officers for the Spokane Section, elected at the December meeting, are as follows: Philip G. Holgren, president; H. J. Doolittle, first vice-president; G. A. Riedesel, second vice-president; and R. E. Tobin, secretary-treasurer. After considerable discussion of two proposed bills on coordinate surveys, there was a round-table discussion of postwar construction activities. It was announced that the Committee for Economic Development has enlisted the cooperation of the Society. The reading of a report on the proceedings of the Local Sections Conference, held in Denver, Colo., in October, concluded the program.

Tacoma Section

The Section's annual "Ladies' Night" was celebrated at the Tacoma Country and Golf Club on January 20. After a turkey dinner had been thoroughly enjoyed, W. A. Kunigk spoke of his many associations with members of the Section, and particularly with Walter J. Ryan, to whom he then presented a certificate of life membership. Following Mr. Ryan's brief speech of acceptance, President Strong introduced the newly elected officers of the Section. These are as follows: Ralph W. Finke, president; Fred M. Veatch, vice-president; and N. E. Olson, secretary-treasurer. The meeting was then turned over to Mr. Veatch, who had arranged a diverting program of group singing, a "fashion show" (with the Section members as contestants), bridge, and dancing.

Tennessee Valley Section

On January 9 the Chattanooga Sub-Section met with local groups of the other Founder Societies. The principal speaker was H. C. Rothwell, district manager of the Smaller War Plants Corporation, who explained the operation of the organization and showed how it has assisted the war effort by coordinating the activities of the local manufacturing plants with the war needs. A colored motion picture, showing the construction of Fontana Dam, concluded the technical program.

The Knoxville Sub-Section held its January dinner meeting on the 24th. The Annual Meeting in New York was covered by Society Director N. W. Dougherty, Prof. A. T. Granger, C. W. Okey, and C. E. Blee. Director Dougherty's son, Lt. Edward Dougherty, then discussed the experiences of an engineer officer with a combat regiment on the front lines in Africa, Sicily, and Italy.

Student Chapter Notes

New York University

The highlight of the Student Chapter's current schedule was a joint smoker held early in November with the local student group of the American Society of Mechanical Engineers. The showing of technicolor sound motion pictures—on the manufacture and use of plywood and the manufacture of steel—comprised the technical program for the occasion. The Chapter reports that meetings are held every other Tuesday afternoon and that these sessions, which are devoted to planning smokers or social events, can boast almost perfect attendance.

The Chapter's mimeographed news sheet, "On the Level," is still being issued, despite war problems and a greatly reduced student body. To quote an editorial from a recent issue: "We will try to keep track of the boys who have graduated, and follow their journey through industry or the armed forces. As in the past, the main aim of this publication is to get everyone to know everyone else, and to maintain contact between those who have graduated and those still on the campus. Unlike other publications, we do not boast of coming out every day, or every week, or at any set time at all. We go to press whenever we feel like it, and whenever something interesting comes along."

ITEMS OF INTEREST

About Engineers and Engineering

Office, Chief of Engineers, Establishes Board of Consultants

REALIZING that the increasing weight of airplanes and the consequent increasing cost and difficulty of airfield construction, necessitate continuation of pavement and other design investigations on a large scale, the Office, Chief of Engineers, has established a Board of Consultants composed of nationally prominent engineers in the fields of pavements and soil mechanics, to advise that office on development and design problems.

The Board of Consultants is composed of the following: Dr. H. M. Westergaard, dean of the Graduate School of Engineering, Harvard University; Dr. Arthur Casagrande, associate professor, Graduate School of Engineering, Harvard University; J. L. Land, chief engineer of the Bureau of Materials and Tests, Alabama Highway Department; O. J. Porter, senior engineer of materials and tests, California Highway Department; T. A. Middlebrooks, Civil Works Division, Office, Chief of Engineers; and Fred C. Lang, engineer of materials and research, Minnesota Highway Department. All except Mr. Lang are members of the Society.

The chief of the Engineering and Development Division, Office, Chief of Engineers, is the temporary chairman of the Board of Consultants, the position being subject to change depending upon military assignment.

C. W. Blakeslee and Sons Celebrates Centennial

To celebrate its recent centennial, C. W. Blakeslee and Sons, general contractors of New Haven, Conn., have issued a stimulating little volume, entitled "A Century of Heavy Construction by C. W. Blakeslee and Sons, Inc., Through Three Generations."

As the foreword points out, "Construction contracting is a business beset by more than the usual risks." Thus it is all the more remarkable when a construction company "has earned the distinction of outlasting the average life of such companies in this country by eighty-seven years."

Starting out with a wheelbarrow as its first piece of equipment, the company came in time to play an important part in the engineering development of New England. Pioneering in sheet asphalt paving, the firm was among the first to put into operation both stationary and portable bituminous mixing plants. And in 1930 the company established the first commercial pre-mixed concrete plant in the region.

N. G. Neare's Column

Conducted by

R. ROBINSON ROWE, M. AM. SOC. C.E.

"DE l'Axe is in Borneo."

"Or at the North Pole!"

"No, at the South Pole!"

"One at a time, please," interrupted the Professor. "If our pendulum code is any good, he can be at only one of those places."

"Then he's on the east coast of Borneo," insisted Joe Kerr, "on the Equator at Long. 118.5 E. He had to be on the Equator, or his bob would have rotated like a Foucault pendulum. The longitude is simply 360° times the ratio of swings, 28,424/86,351. Lucky he picked a day when the equation of time is negligible."

"But he could have been at the North Pole," contended Amos Keatow. "His bob would have rotated thru 360° so as to split the peg on the last swing."

"Better make it the South Pole, then," urged Ken Bridgewater. "He couldn't have set a peg 2 ft N of the North Pole; besides, the sun doesn't shine there on Xmas."

"There's one odd thing they haven't noticed, Professor," said Cal Klater, "the odd number of swings. If the Foucault rotation had been 0° or 360°, an even number of swings would have brot the bob to the starting peg. The odd number, 86,351, meant a rotation of 180°. Neglecting the difference between solar and sidereal days, the latitude must be $\sin^{-1}$ 180/360 or 30° N, the "N" being dictated by the shadow. Since I agree with Joe on the longitude, Alenfer de l'Axe must have been in China, near Chiki, Anhwei."

"So far, so good, Cal, but it takes a third coördinate to fix a position."

"I was coming to that. Letting R be the ratio of swings (86,351) to seconds (86,400), M the cosine of twice the latitude of San Francisco (where the bob was calibrated) and N the cosine of twice the latitude of de l'Axe, then his altitude in feet was:

$$H = 324{,}000\,[32.172\,(1 - R^2) - 0.0850]\,(N - MR)^2 + 0.00023\,(N^2 - M^2R^2)^2 = 4{,}900 \text{ ft}$$

This agrees with the topography, since Chiki is high in the Makin Ling."

"And rules out another solution—a foxhole down to 9,800 ft below sea level," concluded the Professor. "Now here's a new problem without any odd numbers in it.

"Our old friend Hiram Flire was racing his younger brother Lowell at 100 miles per hr to their base at Daggett 60 miles to the south when they ran into a steady west wind. Hi kept his plane headed for Daggett, but Lo flew a straight course and beat his brother in by 40 min. How strong was the wind?"

[*Cal Klaters were Richard Jenney and Anne Othernut (J. Charles Rathbun), the latter correcting for sidereal-solar differences to find de l'Axe at 118° 23' E, 29° 54' N, 4,830' Up, or about 10 mi SW of Chiki. Three friends, Claude W. West, Otto Okay Koch, and Charles B. Walton, have reduced the Bray Function (January Column) to implicit elliptic functions, mathematically superior but practically inferior to the series solution published. The new problem developed from a suggestion by Sgt. Edwin R. Rowe, who found pilots bothered by the quickest-way-home-in-a-wind exercise on the Link Trainer.*]

Suggestions from Employees Boost Production of Construction Equipment

ENORMOUS quantities of 'dozers, scrapers, shovels, and the like have been demanded by advancing military forces. At all times it has been a struggle on the part of manufacturers to meet the schedules necessary to supply the needed equipment. To save time on operations small or large, many times a workman has suggested additions or simplifications which only he would ever notice. Recognizing this fact, many plants have tried and found successful an incentive plan for bringing forth such suggestions.

The net result has been a considerable saving in time and materials coupled with improved quality and working conditions —all resulting in the prime objective, increased production. The improvement in employee-employer relations has also been marked. Apparently there is no wage-scale limit to ingenuity, for some most helpful schemes have been suggested by those with the slimmest pay envelopes. One encouraging feature of most incentive plans in use is that such pay envelopes do not stay slim long when a suggestion proves useful.

The War Production Board has established an "All-American Suggestion Team" composed of companies whose employee suggestions have been outstanding in number and excellence. In addition three awards are given to individuals for outstanding suggestions. They are the Certificate of Merit, Honorable Mention, and the Letter of Commendation. To rate any of these three honors a suggestion must have been proved to be of assistance to the war effort in the plant where it originated, and it must be adjudged by WPB engineers as being worthy of adoption by other war plants.

A very successful program has been in operation for some time at the Caterpillar Tractor Company, which has made the "All American Suggestion Team." This pro-

gram is in charge of a joint labor-management committee which has put on a skillful promotion drive for suggestions. These are collected in locked boxes distributed throughout the plant and are then brought before the suggestion committee. The committee requests an investigation of the merits of the scheme and a report from the department head affected. Upon his recommendation, the committee promptly guides the change through the proper channels for adoption and the person who suggested the improvement is awarded recognition in the form of certificates and pins. Needless to say, these count heavily toward promotions.

At this plant in particular quotas have been increased time and time again and met because of the cooperative spirit engendered by this incentive plan. Employees are anxious and willing to give their best on the job if their efforts are recognized.

Hydroelectric Progress in Canada During 1944

THE ANNUAL review of hydroelectric progress in Canada prepared by the Dominion Water and Power Bureau, Department of Mines and Resources, Ottawa, indicates that the program of wartime expansion in hydroelectric facilities has been virtually completed and that power production for war purposes appears to have passed its peak. During 1944 the net increase in water-power installation was 68,700 hp, comprised almost wholly by the completion of the Brilliant plant (68,000 hp) on the Kootenay River in British Columbia. This was the smallest annual increase recorded since 1939, and no large power projects are presently under construction. In the production of electricity, the figures compiled monthly by the Dominion Bureau of Statistics show an increase of less than 1% for the first ten months of 1944 over the corresponding period of 1943, and a month-by-month comparison shows production during the months of June to September 1944 actually less than in 1943. Seasonal deficiencies in water supply in certain districts contributed in some measure to this lessening of power production, but it reflects as well the readjustment that has commenced in the manufacture of war materials.

Resulting from the new construction in 1944 Canada's total water-power installation, at the end of the year, reached a total of 10,283,213 hp. One-fifth of this total, or 2,000,000 hp, has been installed in the past five years, almost wholly for war purposes and, with the conflict in Europe nearing its final stage, this achievement in hydroelectric development may be assessed as a basic, and one of the most significant single factors, in Canada's vast war-production program.

In addition to the new hydroelectric installations during the war years, much of the power developed and in use prior to the war was diverted from peacetime to wartime use. It is safe to say that about one-third of Canada's water-power development has been used for war production; one industry alone, the aluminum industry, having utilized at peak production one-quarter of all the hydroelectric energy consumed in the Dominion. In the period of readjustment from war to peace, the initial effects of which already are in evidence, it can be anticipated that power surpluses will develop in certain areas. For the most part these surpluses should be moderate and should be absorbed within a reasonable time as industries change over to peacetime production and undertake the problem of supplying the huge backlog of civilian needs.

The war has demonstrated the strength of Canada as an industrial country. In the vast world-wide program of reconstruction which will follow the war, its assets in hydroelectric power have outstanding significance.

NEWS OF ENGINEERS

Personal Items About Society Members

LEIF J. SVERDRUP, brigadier general, Corps of Engineers, U.S. Army, was recently awarded the Distinguished Service Cross for "his work in rushing into operation the Lingayen airfield," which was taken in our invasion of Luzon. In bestowing the decoration, General MacArthur commented, "This is the engineer soldier at his best." General Sverdrup, who is chief engineer to General MacArthur's Expeditionary Forces, was a partner in the St. Louis consulting firm of Sverdrup and Parcel before entering the Armed Services.

HUNTER ROUSE, since 1942 associate director of the Iowa Institute of Hydraulic Research at the University of Iowa, has been appointed director. Professor Rouse joined the engineering staff at the University of Iowa in 1939 in the capacity of professor of fluid mechanics and consultant to the Iowa Institute of Hydraulic Research.

SAMUEL I. ZACK, until lately sanitary engineer for the Stone and Webster Engineering Corporation, of Boston, Mass., has accepted a similar position with the Harrisburg (Pa.) firm of Fleming, Corddry and Carpenter, Inc.

WILLIAM M. ANGAS was recently promoted from the rank of captain in the Civil Engineering Corps of the U.S. Navy to that of commodore. At present he is in charge of a construction brigade in the Pacific.

HAROLD A. VAGTBORG has resigned as director of the Armour Research Foundation, Chicago, Ill., in order to become president of the Midwest Research Institute, Kansas City, Mo.

FRANCIS J. MAGNUSON, formerly assistant civil engineer in the Office of the City Engineer, St. Paul, Minn., has accepted the position of city engineer of Rochester, Minn.

JACOB L. CRANE, JR., director of urban studies for the National Housing Agency, Washington, D.C., has been invited by the British government to go to England as a consultant on housing and city planning.

JAMES S. LEWIS, JR., formerly construction superintendent for the Tennessee Valley Authority at Dandridge, Tenn., is now on the engineering staff of the Royal Kershaw Company of Montgomery, Ala., for whom he is currently engaged on some Army work at Panama City, Fla.

FRANK L. RASCHIG has been reappointed Ohio State Director of Public Works for a two-year term to end January 1, 1946. Mr. Raschig has held the post since January 1940.

GORDON M. FAIR, professor of sanitary engineering at Harvard University, has been elected to a three-year term on the board of scientific directors of the International Division of the Rockefeller Foundation.

ERWIN HARSCH has severed his connection as principal highway engineer for the Tennessee Valley Authority at Knoxville, Tenn., in order to accept the position of bridge engineer for R. Steuart Royer and Consoer Townsend and Associates, with headquarters in Richmond, Va. The two firms have merged to make a study of express highways for the Virginia State Highway Department.

WALTER V. SULKOWSKI is now connected with the National Gypsum Company, of Buffalo, N.Y. He was previously associate structural engineer for the Tennessee Valley Authority at Knoxville, Tenn.

DON M. FORESTER was recently appointed project engineer for the U.S. Bureau of Reclamation on its eighteen-million-dollar project in the San Luis Valley in Colorado. An employee of the Bureau of Reclamation since 1932, Mr. Forester has been attached to the branch of project planning in Denver since 1941. The project office is at Monte Vista, and it is expected that work will begin as soon as men and material are available.

DAVID J. BRUMLEY, lieutenant colonel, Corps of Engineers, U.S. Army, is at present post engineer at Maxwell Field, Ala., where he has charge of the construction and maintenance of utilities, streets, grounds, and runways. Colonel Brumley was previously base engineer at the Columbia (S.C.) Army Air Base.

WILLIAM F. TOMPKINS has been promoted from the rank of brigadier general, Corps of Engineers, U.S. Army, to that of major general. He is on duty with the War Department General Staff and is director of the Special Planning Division of the War Department Special Staff. This division is charged with demobilization and postwar planning for the War Department. General Tompkins' headquarters are in Washington, D.C.

GLEN N. COX, head of the department of hydraulic engineering at Louisiana State University, has been assigned to the Louisiana State Department of Public Works, at Baton Rouge, La., for a period of six months. While with the Department of Public Works, Professor Cox is serving as chief of the Hydraulic Section, and is engaged in making flood control and drainage investigations and in the design of hydraulic structures.

MYRON S. FALK, who has been serving as consulting engineer to the Ordnance Department of the U.S. Army in Washington, D.C., has just received a citation from the War Department Army Service Forces with the Civilian Award of Merit. The citation reads, "For meritorious service in the War Department from January 13, 1941, to present. During this period he has served faithfully and loyally. His devotion to the department, as exemplified in his services, has been an inspiration, and his services have been invaluable during the rapid expansion of the department."

ALLEN CAUSBY is now sales engineer for the Jack B. Haile Machinery Company, with headquarters at 2118 North Gale Street, Indianapolis, Ind. He was formerly sales engineer for the Armco International Corporation, of Chicago, Ill.

LEONID HASSILEV has been appointed executive secretary of the French Mission of Railroads and Public Works in Washington, D.C. Mr. Hassilev has been in the service of the French Provisional Government since September 1944, when he became assistant chief of the Industrial Division of the Supply Mission for France. Prior to that he had been structural designer on several dock and power-plant projects in this country.

WALKER R. YOUNG has been appointed chief engineer of the U.S. Bureau of Reclamation, filling the vacancy caused by the retirement of S. O. HARPER in December 1944. Connected with the Bureau of Reclamation since 1911, Mr. Young has served as assistant chief engineer for the past four years, and as acting chief engineer since Mr. Harper's retirement.

GODFREY L. OAKLAND, associate engineer for the U.S. Geological Survey, was recently transferred from Ithaca, N.Y., to the Roswell (N.Mex.) office of the Survey.

FRANK L. DIETER has resigned his position as planning engineer for Arlington County, Virginia, in order to take the post of director of planning for Durham, N.C.

CHARLES MACDONALD is now associated with Clarke, Rapuano and Holleran, Robinson and Steinman, and Howard, Needles, Tammen and Bergendoff on the preparation of plans and specifications for Deegan Boulevard—an expressway in the Borough of the Bronx, N.Y., being designed for the State of New York as a postwar construction project. Mr. MacDonald was formerly county engineer for Westchester County, New York.

FORREST F. VARNEY, senior engineer for the Sacramento District of the U.S. Engineer Office, has been assigned as field section engineer in charge of the Fresno (Calif.) Section, Operations Division. He relieves MAJ. J. L. NEWMAN, who has been ordered to Fort Belvoir, Va., for reassignment to overseas duty.

WILLIAM W. CALDWELL, vice-president of the building construction firm of Iglehart, Caldwell and Scott, Inc., of New York, has been elected president to succeed Stewart B. Iglehart.

JAMES JOSEPH BREEN, lieutenant (jg), Civil Engineering Corps, U.S. Naval Reserve, is a recent recipient of the Silver Star Medal for service as set forth in a secret citation. The portion of the citation that can be disclosed at this time states that he "distinguished himself... by gallantry and intrepidity in action in the assault upon, and occupation of, an enemy-held island, and carried out his duties in a calm and efficient manner despite determined enemy opposition in the face of heavy mortar, machine gun, and sniper fire."

LOUIS R. DOUGLASS, who was transferred last year from Denver, Colo., to the position of engineering assistant to the Commissioner, Bureau of Reclamation, Washington, D.C., has been named Assistant Regional Director of Region No. 3 of the Bureau. This region, under Regional Director E. A. MORITZ, embraces the lower Colorado River Basin. Mr. Douglass assumed his new duties on December 28, with headquarters at Boulder City, Nev.

FREDERICK A. SMITH has severed his connection as production planning engineer for the Albany Felt Company, Albany, N.Y., in order to accept the position of industrial engineer for E. F. Houghton and Company, of Philadelphia, Pa. Mr. Smith has been serving as secretary of the Mohawk–Hudson Section.

RAY K. LINSLEY, Jr., who is on the engineering staff of the U.S. Weather Bureau, has been transferred from the Sacramento (Calif.) office of the Bureau to Washington, D.C., where he will be assistant to MERRILL BERNARD.

STANFORD P. MCCASLAND, after serving in England as a lieutenant colonel in the Corps of Engineers, U.S. Army, has been discharged to accept appointment as engineer for foreign investment for the Export-Import Bank, with headquarters in Bogota, Colombia.

RALPH G. WADSWORTH has returned to private practice in San Francisco, with offices at 625 Market Street. Until lately he was state director for the U.S. Employment Service at Sacramento, Calif.

JAKE OSOFFSKY is now on the engineering staff of the Aeronautical Society of America, with headquarters at Hampton, Va. He was recently discharged from the U.S. Army.

ROBERT S. MAYO, major, U.S. Marine Corps, formerly Marine Corps representative at the Engineer Board, Fort Belvoir, Va., is now overseas as executive of a Marine Corps Engineer Battalion.

REX J. ALLAN, major, Corps of Engineers, U.S. Army, has been transferred from Seattle, Wash., where he has been serving as chief of the general engineering branch of the Seattle Engineer District, to Camp Beale, Calif.

HENRY E. PAPE, JR., resigned his position as engineer with the U.S. Engineer Office in order to accept a commission as ensign in the U.S. Naval Reserve. He has been stationed at Key West, Fla., in connection with mine warfare, but was recently transferred to the Amphibious Training Base at Coronado, Calif.

RAYMOND LAMOREAUX was recently promoted from the position of lieutenant commander in the Civil Engineering Corps of the U.S. Navy to that of commander. He is attached to the staff of the commander in chief of the Pacific fleet and Pacific Ocean areas.

DON M. HOFFMAN has been promoted from the rank of lieutenant colonel in the Ordnance Department of the U.S. Army to that of colonel.

DECEASED

CLARENCE EDSON ALDERMAN (M. '[illegible]) technical specialist in the Steel Division of the War Production Board, Washington, D.C., died on December 5, 1944. Mr. Alderman, who was 76, was for some years consulting engineer and general manager for the Boston (Mass.) engineering and contracting firm of Gascoigne, Alderman and Shattuck. From 1920 to 1940 he was chief of estimates and specifications in the Construction Division of the War Department, Washington, D.C., and for the past year had been connected with the War Production Board.

EDWARD EVERETT BETTS (M. '13) retired engineer of Chattanooga, Tenn., died on January 18, 1945, at the age of [illegible]. Long identified with the engineering history of Chattanooga, Mr. Betts first went there in 1886 on railroad construction work. From 1892 to 1911 he was engineer in charge of the Chickamauga and Chattanooga National Military Park, and during this same period he was detailed by Elihu Root, then Secretary of War, to act as special consultant on the development of the Vicksburg National Park. From 1911 to 1913 he was chief engineer for the Hamilton County Highway Commission. In the latter year he established the Edward E. Betts Engineering Company, which was responsible for the construction of many municipal improvements in Chattanooga and neighboring towns. Mr. Betts retired in 1931, and his firm is now operated by his son under the name of the Betts Engineering Company.

GEORGE HENRY BLISS (M. '15) director of the Merchants National Bank, Newburyport, Mass., died on November [illegible], 1944, at the age of 69. Early in his career Mr. Bliss was division engineer for the U.S. Reclamation Service on the Lower Yellowstone Project. He had, also, constructed sewerage facilities for the cities of Newburyport and Malden, Mass., and at one time was with the New York, New Haven and Hartford Railroad. From 1915 to 1930 he was a member of the Bliss and Perry Manufacturing Company in Newburyport, and since 1930 had been engaged in banking and investment work in Newburyport.

WALTER CHRISTMAS BODYCOMB (Assoc. M. '14) with United Engineers and Constructors, Inc., of Philadelphia, Pa., died on December 1, 1944. He was 69. Mr. Bodycomb had been superintendent of construction for Westinghouse, Church, Kerr and Company at Niagara Falls, N.Y., and with Dwight P. Robinson and Company, in Indianapolis, Ind. For the past twenty years he had been with United Engineers and Constructors Inc.—

for part of this period as general superintendent of construction in various cities, including Bessemer, Ala., Newark, N.J., and Chattanooga, Tenn. He had been in the Philadelphia office since 1937.

EDWIN WALLACE BOROUGH (Assoc. M. '18) an engineer for the Real Estate Bureau of the New York Board of Estimate, died on February 3, 1945, as a result of injuries suffered ten days before when he fell while inspecting a city-owned building. Mr. Borough, who was 60, had been with the Board of Estimate for the past four years, and prior to that was in charge of the works division of the city's Emergency Relief Bureau. In his earlier career he worked as a construction engineer on projects on the West Coast and in New York—among them the Hell Gate power plant of the Consolidated Edison Company.

SAM WIGFALL BRADSHAW (M. '20) assistant engineer for the Bethlehem Steel Company, of Bethlehem, Pa., died recently at the age of 70. From 1891 to 1916 Mr. Bradshaw was with the Pennsylvania Steel Company, with the exception of two years with Milliken Brothers, engineers and contractors of New York City. He served the Pennsylvania Steel Company in varying capacities, finally becoming assistant engineer. Mr. Bradshaw had been with the Bethlehem Steel Company since 1916.

BENJAMIN LUCIEN CAMPBELL (M. '33) retired civil engineer of Portland, Ore., died at Medford, Ore., on December 9, 1944. His age was 60. Prior to his retirement in October 1944, Mr. Campbell had for a number of years been in the U.S. Engineer Office at Portland—as assistant engineer and associate engineer, successively.

THOMAS HENRY CARVER (M. '15) retired civil engineer of Seattle, Wash., died on December 22, 1944, at the age of 73. Mr. Carver was in the Engineers' Department of the City of Seattle from 1905 until his retirement in December 1940. For most of this period he was assistant city engineer, and from 1907 on he had been in charge of the design and construction of a water supply and distribution system. He designed and built the Cedar River masonry dam and Diablo Dam on the Skagit River.

JUAN CRISOSTOMO DORIA PAZ (Jun. '35) instructor in structures and sanitary engineering at the University of Nuevo Leon, Monterrey, Mexico, died on December 28, 1944. Mr. Doria Paz, who was 33, was born in Mexico, and educated in the United States, graduating from the Agricultural and Mechanical College of Texas in 1934. Before becoming connected with the University of Nuevo Leon, he was designer and draftsman on steel work for Cia Fundidora de Fierro y Acero de Monterrey.

WILLIAM BENJAMIN GREGORY (M. '09) professor emeritus of hydraulics at Tulane University, New Orleans, La., died there on January 29, 1945, at the age of 73. Professor Gregory joined the engineering staff at Tulane in 1897, and from 1905 to 1938 had the rank of professor of experimental engineering and hydraulics. He retired in the latter year with the rank of professor emeritus. Coincidentally, he served as consulting engineer to the Mississippi River Commission on tests of hydraulic dredges and to the U.S. Corps of Engineers on hydraulic tests for the Bonnet Carré Spillway. Also, for fifteen years he spent his summers with the U.S. Department of Agriculture, specializing in rice irrigation and drainage work. During the first World War he served as a major in the A.E.F., and later became a colonel in the U.S. Engineers Reserve Corps.

THOMAS J. HENDRIX (Assoc. M. '44) captain, Corps of Engineers, U.S. Army, was killed in France on December 31, 1944. Mr. Hendrix was 35 years old, and an alumnus of Alabama Polytechnic Institute, class of 1930. For twelve years following his graduation Mr. Hendrix was with the Alabama State Highway Department, working up from the position of draftsman to that of assistant engineer. Since January 1942 he had been a captain in the Corps of Engineers, U.S. Army.

HARRY LEVINGSTON MCCARTHY, JR. (Jun. '42) Private First Class, Air Forces, U.S. Army, was recently killed in action over Germany. His age was 24. Following his graduation from the Catholic University of America in 1941, Mr. McCarthy became connected with the J. G. White Engineering Corporation on the Lake Ontario Ordnance Works at Modeltown, N.Y. He enlisted in the Air Forces about a year ago. Mr. McCarthy's home was in Washington, D.C.

JOHN V. MCKINNEY (M. '30) president of the Iowa-Illinois Gas and Electric Company, of Rock Island, Ill., died on January 27, 1945, at the age of 51. During the first World War Mr. McKinney served in the 333d Field Artillery of the U.S. Army, having the rank of captain. He then became connected with William G. Woolfolk and Company, Inc., Chicago consultant, for whom he served as personal representative in the reorganization of the Kansas City Railways Company. From 1927 to 1943 he was executive vice-president of the Kansas City (Mo.) Public Service Company in charge of engineering and finance and, coincidentally, for most of this period he was also vice-president of the Wyandotte Railways Company.

THOMAS RIGGS (M. '15) commissioner of the International Boundary Commission, died at his home in Washington, D.C., on January 16, 1945. Mr. Riggs, who was 71, spent his early career in the manufacture of lumber and in mining. He then (1903) became connected with the United States and Canada Boundary Survey, and from 1906 to 1918 was engineer, successively, for the Alaska Boundary Survey and the Alaskan Engineering Commission. President Wilson appointed him Governor of Alaska in 1918, and he held the post for three years. From 1922 to 1935 Mr. Riggs was engaged in mining activities; and since the latter date had been commissioner of the International Boundary Commission, which fixed the lines between the United States, Canada, and Alaska. Since 1938 he had also been a member of the Alaska International Highway Commission.

GEORGE ARTHUR SEAVER (M. '4[illegible]) engineer for the George J. Glover Company, Inc., of New Orleans, La., died suddenly on January 20, 1945, at the age of [illegible]. At the outset of his career Mr. Seaver was with Sanderson and Porter, of New Orleans, for three years and the New Orleans Railways Company for one year. Since 1909 he had been with the George J. Glover Contracting Company and, at the time of his death, was a director of the organization.

CLIFFORD MILTON STEGNER (M. '1[illegible]) of Cincinnati, Ohio, died on January [illegible], 1945, at the age of 67. From 1900 to 19[illegible] Mr. Stegner held various positions in railroad, bridge, and building construction work, and from the latter year to 1926 he maintained a private engineering and architectural practice in Cincinnati. Beginning in 1927, he was for a number of years Commissioner of Buildings for the City of Cincinnati. He retired about a year ago. Long active in the Cincinnati Section, Mr. Stegner had served it as president.

GEORGE LEWIS SWENDSEN (M. '[illegible]) consulting engineer of Long Beach, Calif., died at his home there on January [illegible], 1945. Mr. Swendsen, who was 75, spent his early engineering career in Utah. Then, from 1921 until 1936, he was with the Fresno Irrigation District at Fresno, Calif.—first, as engineer and general manager and, later, as chief engineer. Later he established a consulting practice in Long Beach.

CHARLES DAVIS VAIL (M. '09) Colorado State Highway Engineer, Denver, Colo., died in that city on January 8, 1945. Mr. Vail, who was 76, spent his early career in railroad engineering and water-works construction. Since 1909 he had been in Colorado, where he held the posts of railway and highway engineer for the Colorado Public Utilities Commission and manager of the Denver Department of Improvements and Parks before being appointed State Highway Engineer in 1930. The Mount Evans Road, which has been called "the highest highway in the world," is one of the many Colorado highway projects built during his administration.

JOSEPH WEIDEL (M. '18) retired civil engineer of San Diego, Calif., died at National City, Calif., on January [illegible], 1945. From 1917 until his retirement two years ago Mr. Weidel was valuation engineer for the Atchison, Topeka, and Santa Fe Railway System, with headquarters in Chicago, Ill.

WILLIAM HENRY WETZLER (M. '1[illegible]) who was with the Douglas Aircraft Company at Santa Monica, Calif., died on December 23, 1944, at the age of 6[illegible]. Mr. Wetzler had been consulting engineer and principal surveyor for the American Bureau of Shipping in New York; designing engineer for the Los Angeles Department of Water and Power on a section of the Colorado Aqueduct; and designing engineer for the Los Angeles County Flood Control District. More recently (1929 to 1943) he had been structural designer for the City of Chicago Bureau of Water.